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NOVEL FEATURES OF THE HURONIAN COMPANY'S WATER POWER DEVELOPMENT, HIGH FALLS, ONTARIO.*

The Huronian Co. was formed to develop and transmit power for mining operations in what is known as the Sudbury District of Ontario. The principal mines are at Copper Cliff, Creighton and Crean Hill, with the smelter at Copper Cliff. This district is about 40 miles north of Georgian Bay, Lake Huron. The High Falls on the Spanish River were acquired and in the spring of 1904 the preliminary work was started. High Falls is about 4 miles north of the "Soo Branch" of the Canadian Pacific Ry., and 28⅓ miles west of Sudbury Station. A line of track was laid to the Canadian Pacific Ry. The Spanish River at High Falls drains an area of 2,150 sq. miles, in which the average rainfall is about 30 ins. Owing to the nature of the covering of the watershed and the lakes in the head waters, the minimum flow is high, being about 0.71 cu. ft. per sec. per sq. mi.

For six miles above High Falls the river is a succession of rapids. To prevent the formation of anchor ice, and to provide an ample reservoir, it was considered necessary to drown these rapids. The river level was raised 18 ft., increasing the pressure head to 87 ft. Immediately at the head of the falls are rocky islands which break up the stream, finally dividing it into the east and west channels. The two branches unite a short distance below and form High Falls Island.

The scheme of works was in some ways unusual but was arranged to secure the full river flow, to satisfy lumbering conditions, and to utilize the natural advantages of the site. We have herein briefly taken up those novel features claimed as advantageous.

DAMS.—Work was carried to completion in spite of the severe winter of 1904-5. The system of dams necessary to control the flow was somewhat complicated, as shown in Fig. 2. Dams 1, 2 and 4 were started first. Log slides were made in Dam 1, and two temporary openings were left in Dams 1 and 2, to pass the water when it became necessary to block the east channel. This was closed by a crib cofferdam against a head of 32 ft. of water. The cofferdam was built in the form of a letter V, in plan. Each leg abutting on the rock and projecting outward and up-stream at an angle and being finished square, left a key-shaped space between the legs. This space was accurately measured and a proper crib was built up-stream from Dams 2 and 4, partially loaded, and lowered by tackle to within a short distance of the proposed location. It was then built up and loaded until it was within a few inches of the bottom. Next the position of the crib was adjusted and it was lowered into place as far as possible by tackle. When proper direction of its course was assured the ropes were quickly loosed and it was carried into position by the current. The face of the cofferdam was double sheeted and made as tight as possible to the river bottom.

VIEW OF THE GENERAL SITE OF POWER DEVELOPMENT, HIGH FALLS, ONTARIO.

As lumbering on this river is heavy, a system of booms was anchored in the river above, guiding the logs to the slides in Dam 1. To insure water enough for logging, the crest of Dam 3 was made 18 ins. higher than that of Dam 5.

CONSTRUCTION FEATURES.—All dams are on rock foundations with key trench anchors. The rock was made absolutely clean and dusted with neat cement. Over this was a 4-in. layer of 1 to 3 mortar, on which concreting was started. The concrete was all 1:3:5 mixture, deposited very wet. Huge rocks were freely used, but none were allowed within 9 ins. of the face of the work, nor within 12 ins. of each other. All were carefully scrubbed, bedded and so placed as to bond the work as much as possible.

While much concrete was laid at temperatures ranging from 25° above zero to 30° below, no difficulty was encountered. Some precautions, however, were taken. The mixing water was heated by turning a ¾-in. steam pipe into the barrel supplying the mixer, and a jet of live steam was used in the mixer. The cylinder was closed by wooden coverings during mixing. No attempt was made to heat sand or stone as such need never arose. In winter care was taken to use only cement attaining an initial set in 65 minutes. With these precautions, no trouble resulted here in placing concrete at very low temperatures, even in walls as thin as 10 ins.

The bulkhead was constructed in the same general manner as the other dams. The exciter wheel intake is separate from those for main power wheels, so as to permit a smaller spaced screen. This necessity at the intake, and the advisability of placing the exciters in the middle of the power-house flow, required bending the excited penstock from a position at the end of the wall to the center of the other penstocks. The bulkhead was housed to protect operators in severe weather.

The main penstocks are 9 ft. in diameter, of steel plate, resting on concrete saddles, anchored at their centers and having expansion joints near the bulkhead wall and near the power-house. To prevent formation of ice in the penstocks, they are covered with a wooden structure, built as nearly airtight as possible. This was considered necessary, as the temperature falls as low as — 45° F., and it has proved effective. The maximum overload velocity in the penstocks is 7.2 ft. per sec. The air pipes at the upper ends are also packed for protection against freezing. A line of dry pipe follows the wooden structure and is connected to a 50-HP. pumping unit in the station for furnishing fire protection.

The turbine pairs have a maximum HP. of 3,550 and are controlled by Sturgess governors. The exciter turbines are similarly controlled. All governors are handled from the control board by the operator, who also controls all machines in the power-house from this point. This control board is a marble bench placed on a gallery

*This article is based on a paper read before the Canadian Society of Civil Engineers, April 25, 1907, by Messrs. Robt. A. Ross, M. Can. Soc. C. E., M. Am. Inst. E. E., and Henry Holgate, M. Can. Soc. C. E., M. Am. Soc. C. E., of Montreal, Canada.

to give the operator a clear view of the station and the switch apparatus in the tower. All high-tension switches are of distant-control type. The 35,000-volt switches on outgoing lines, with the lightning arrestors, are put at the top of the tower. The 2,400-volt apparatus and main leads of the generators are in the base. The only voltages in this gallery are from the excitation and control lines, and none above 125. coils, and that even then no harm can result outside of the cases, as the pressure of an oil explosion has been determined as always below 100 lbs. per sq. in. Normal expansion of the oil, or that due to short circuits, is cared for by the wall tank. The cases are piped to an underground tank at one end of the building. This is divided into two parts: one for clean oil, the other for dirty. Clean oil is forced into the cases

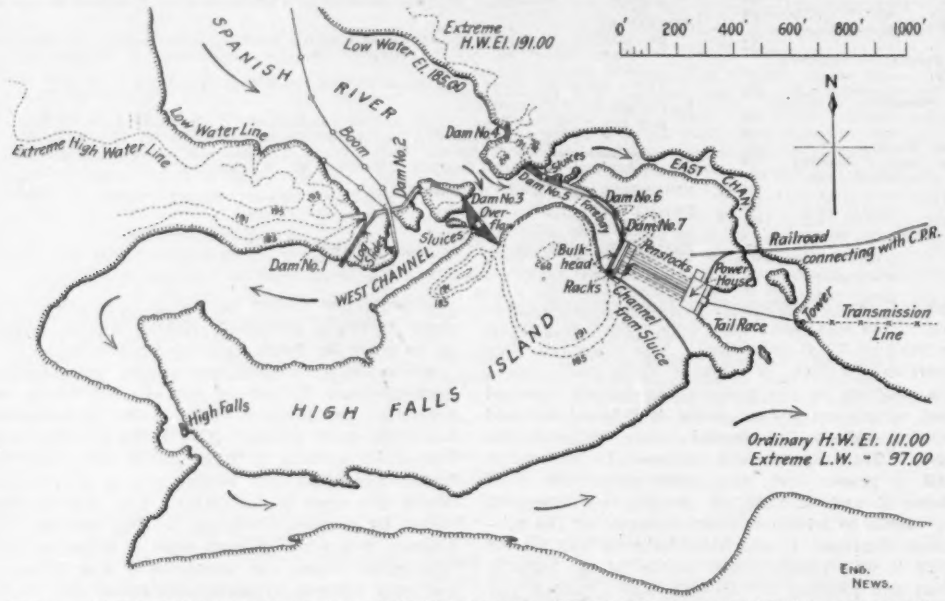


FIG. 2. LOCATION PLAN OF DEVELOPMENT WORKS, HURONIAN CO., HIGH FALLS, ONTARIO.

The control board is placed low, and instead of using marble panels for the instruments, which arrangement would have prevented a clear view of the station, these instruments are carried by pillars along the face of the platform.

The generators are each 2,500 KVA., 3-phase, 25-cycles, 2,400-volt revolving field type. In connection with testing these machines, it is interesting to note the procedure of loading. The scheme was to run one machine as a synchronous motor, rotation reversed from normal direction, operating as load on the other. Both machines were brought to full excitation and connected before starting. The gates on the generator wheel were gradually opened, and both machines came up to speed, in synchronism, with the motor driving its turbine in reverse of normal direction. When both machines were at speed, the gates on the wheel of the motor were gradually opened, obtaining a water brake load. It was possible to get any load, and any power factor by proper excitation of the motor fields.

as required by compressed air, while the dirty, flows by gravity to the proper compartment. Compressed air is furnished by a tank and compressor, installed for cleaning and blowing purposes. This method of handling the oil was criticized by the transformer builders, who claimed that moisture from the compressed air would be forced into the oil, rendering it unfit for the cases. The engineers forced a quantity of dry oil back and forth several times between two connected vessels and after the tests absolutely no moisture could be detected. However, as an extra precaution, air is taken directly from the tank only, in which all moisture due to compression is deposited.

The transmission line, about 29 miles long, operates at 35,000 volts and supplies five substations. It consists of two three-phase circuits of No. 1 copper wire. One line is transposed three times, while the other runs straight. Owing to wire spacing, it was inadvisable to run both circuits on one single pole line, but in-

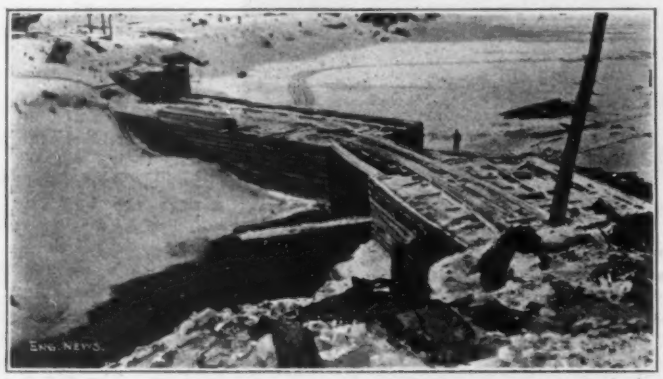


FIG. 3. KEY-SHAPED OPENING IN COFFERDAM, HIGH FALLS, ONTARIO.

FIG. 4. KEY CRIB READY FOR PLACING IN COFFERDAM, HIGH FALLS, ONTARIO.

Six 667-KW. transformers have been installed. They have new features worth noting. The cases are entirely of boiler iron designed to withstand an explosive pressure of 150 lbs. per sq. in., and are so piped as to be full of oil at all times. This is accomplished by connection to a carefully covered wall tank. No space is left in the cases for the accumulation of gases. It is claimed that explosions can occur only when the oil is allowed to sink below the tops of the transformer

stead of adding the second, a double pole construction was adopted, and made to avoid any considerable guying or strutting. Special malleable iron pins were used. One wire is carried at the top of each pole, where a bracket is attached by a through bolt and lag screw.

The engineers for this development are Ross & Holgate, Montreal, Canada. We are indebted to Mr. Henry Holgate for photographs and information in addition to the paper mentioned.

THE ENGINEER AS A PROFESSIONAL *

By GEORGE H. BENZENBERG,† President, ... Soc. C. E.

The constitution of our society provides that the president shall deliver at the annual convention an address, presumably consisting of a general résumé of the most important work in progress and of whatever advance has been made in the engineering art during the past year.

Such a statement, however, would be but a repetition of what is being currently presented by the various journals, magazines, and such other publications as are devoting their columns to engineering subjects. All these keep the engineer well informed, not only of all notable work under construction, but also of all that is being projected. Through the perusal of these ably edited and carefully compiled periodicals, we are sufficiently enabled to keep fully abreast of the times, in a statistical and instructive way, without my adding further details by a perhaps tiresome summary at this time.

It may not be inappropriate, however, to call your attention to the fact, that during no similar period in the history of engineering in this country have so many works of such gigantic magnitude, requiring the expenditure of such vast sums of money, been undertaken or entered upon as during the past year. Among these, the principal works, probably not over nine or ten in number, are all devoted to improving or enlarging present facilities for navigation, travel and commerce, or to providing new channels and new terminals for the accommodation of such, and involve the expenditure of nearly seven hundred millions of dollars, while nearly as large a sum is to be spent from public funds for the development or improvement of water supplies, the betterment of sanitary conditions, the reclamation of arid lands, and the construction or reconstruction of highways, bridges, and other public works for the health, relief, and convenience of man.

It is, however, not only the constantly increasing needs of commerce and transportation, and the comfort and welfare of the public at large, that engage the talent of the engineer. The prevailing tendency to acquire profit and benefit by the introduction of more economical processes of construction and manufacture, as well as by the reduction of wastes, makes it imperative to enlist his analytical and inventive skill and his trained and experienced judgment in almost every branch of human activity, and to secure his advice or approval in every important enterprise.

Hence, everywhere, immense interests and ever-increasing responsibilities are being entrusted to the engineer by private as well as corporate organizations, and so thoroughly has he been able to meet every expectation, to fulfill every obligation, and to demonstrate his ability to meet every emergency successfully, that his service is considered as so elementary, so absolutely essential, that his counsel is not only invariably sought in the line of design and construction, but very frequently also as to the possibility or probability of any undertaking becoming a profitable venture. This, of course, is not only true with reference to the engineer in America, but is equally true as to his connection with the industrial development in every other country.

It is in keeping with the world's practical grasping at every opportunity to profit by the knowledge of the highest and best exponents before entering upon or engaging in any great or important venture. These exponents, therefore, should not only be well informed, accomplished, and gifted in their calling, but they must also be the representative of the very best and highest type of that which is implied by American citizenship. Besides being designers and constructors of works for the upbuilding of commerce and every other industry, they should

*Presidential address at the annual convention of the American Society of Civil Engineers in the City of Mexico, July 8, 1907.

†Consulting Engineer, Milwaukee, Wis.

a[illegible], to come up to the standard of the profession, become foremost and eminent among their fellow men.

When this high station has been reached by honorable and distinguished achievement, the world has always with delight exhibited its admiration and approval, and been pleased to honor the profession. This marked position of trust, influence, and eminence which the profession has attained so signally in the industrial world is undoubtedly due to the fact that engineering has become a science of the highest standard, wonderfully developed as such within the past century and especially during the last fifty years.

This development and progress has been particularly along the line which constitutes the very essence of engineering, and consists in establishing and advancing a thorough knowledge and understanding of the various properties of material, of the forces and latent energies of Nature, and of their economic and intelligent application to the needs and benefit of man. This present knowledge has been acquired by faithful and patient study, by close and careful investigation, by thorough and systematic experiments and tests, and by compiling and communicating the results thereof by reports and publications, in order that the profession might have the full benefit of such research and continue the same for the information and benefit of its members.

There was a time when such information was not to be had. The engineer had but two ways of acquiring professional knowledge, either as an apprentice to some one experienced in engineering, or by his own investigation and experiment, often made at the expense, and sometimes to the injury, of his employer. At the present time, the thoughts, works, and valuable experiences of engineers in every branch of the profession are preserved in the form of reports and papers, that not only describe but illustrate the work of which the author had charge or with which he was associated, and relate in detail the problems and often the difficulties which were encountered, and the manner in which they were successfully overcome. Add to this the thorough and practical discussion which papers of such character usually call forth, revealing often the very best experiences and practice of others, and you have a way of imparting and acquiring knowledge that was not much more than thought of fifty years ago.

Furthermore, the various engineering colleges and technical schools of to-day contain libraries whose shelves are stocked with treatises containing specific and valuable instruction in engineering, as well as with official reports on engineering work. They also possess complete laboratories, thus enabling the student in every branch of the profession to become at least somewhat familiar with the practical end of his study and to train his mind in the proper method of conducting experiments and of investigating and diagnosing the engineering problems which may present themselves, or which may be entrusted to his charge. Moreover, every engineer of to-day, besides his collection of books of reference, keeps himself supplied with all the current literature and with every report and article published pertaining at least to that branch of engineering in which he is especially engaged, in order to remain well informed and abreast with the current conception, practice, and experience of the craft.

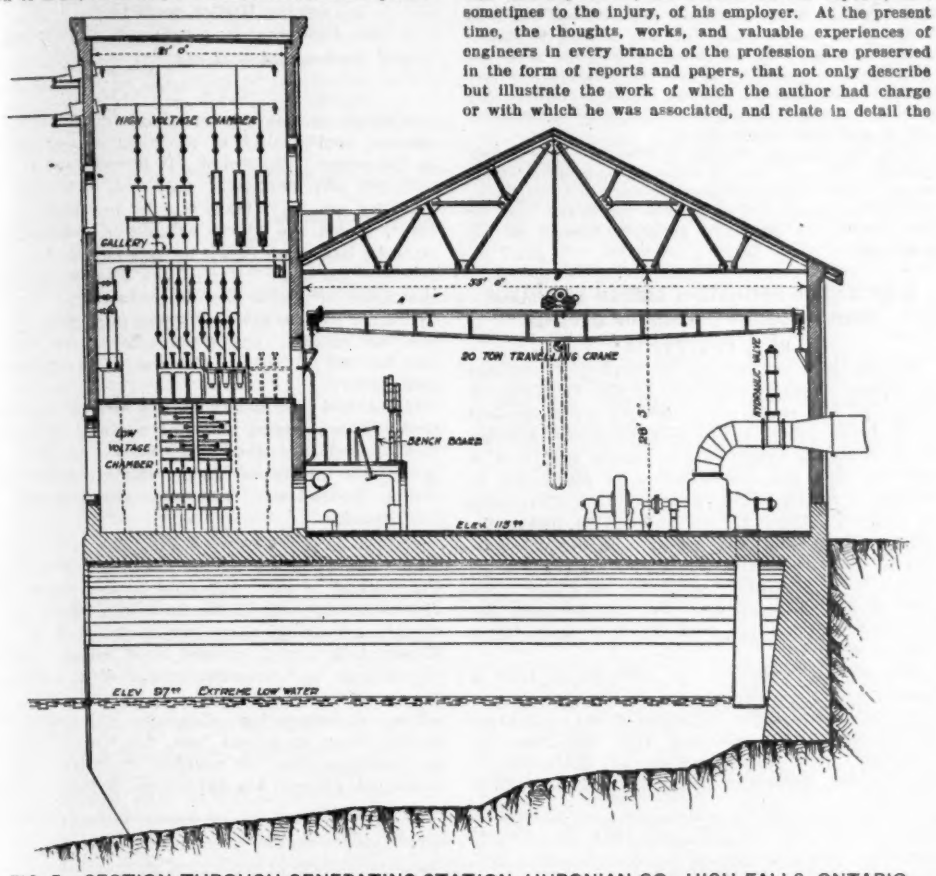


FIG. 5. SECTION THROUGH GENERATING STATION, HURONIAN CO., HIGH FALLS, ONTARIO.

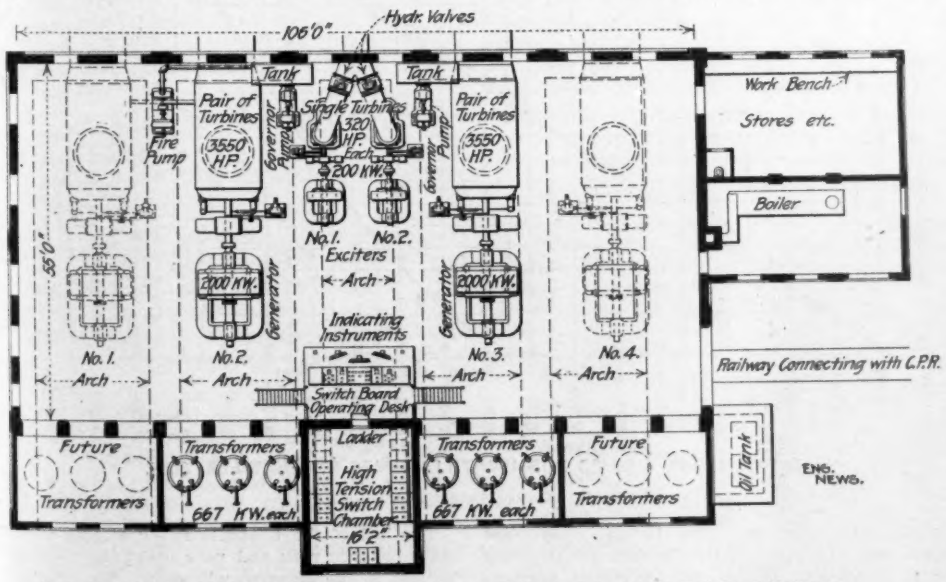


FIG. 6. PLAN OF GENERATING STATION, HURONIAN CO., HIGH FALLS, ONTARIO.

To promote and foster this service further, and to maintain the high standard of the profession among its members, as well as in the estimation of mankind, the profession in our country organized this society, as well as many kindred associations relating to the different branches of professional work, for the advancement of the individual engineer.

To the younger generation of engineers, who have or have not had the benefit of a technical education, a membership in this and kindred societies is of inestimable value, for it affords them the opportunity not only of participating in practical discussions, but also of having access to valuable documents, papers, drawings, and publications, containing a great mass of information which otherwise is not to be had, and which the earlier engineers did not possess. The present very rapid and remarkable growth in the membership of this society demonstrates that this fact is now fully understood and appreciated.

This advantage will doubtless lead the younger engineer to still greater achievements in his time, providing he does not entirely lose sight of the fact, that, though at college he may have learned how to proceed in preliminary investigation and study, and how to apply his knowledge, he has not as yet, by practice or experience, acquired the requisite judgment or the necessary discernment and prudence so essential to success in designing and carrying out engineering works.

It may be properly stated, therefore, that the present-day engineer largely owes whatever success he may have achieved, or reputable position he may occupy, primarily to the advantage which the profession has accorded him, through the close study and diligent research of others who have preceded him and have given the benefit of their learning and experience to the craft, and to which he in turn has likewise added his share for the benefit and welfare of others who may follow.

If this be true, and the engineer, because of this service and also the eminence of his profession, occupies to-day a higher position in the world and enjoys a standing and reputation which compares most favorably with that of any other profession, then the question very properly arises, what duty does he in return owe to the profession; what should be his attitude toward it and his brother engineer, and what position must he ever maintain before the community at large, in order to receive always the full confidence to which he and it should and must always be entitled? This query is a pertinent one, which no engineer should disregard or hesitate to answer.

The engineer who is true and loyal to the pure purposes and noble and lofty character of his profession will bring to it the love, pride, and enthusiasm to which it is justly entitled because of its mission and its achievements. His true devotion to duty allows no unworthy sentiment, interest, or motive to influence him in his professional counsel or work. He places his profession always above himself, and carefully avoids every connection with any undertaking of the integrity or honesty of purpose of which he entertains a doubt. He is mindful that every act of his shall reflect creditably and elevate the standing and reputation of engineering, nor does he hesitate to exert his influence, his power, or his authority against any questionable proposition.

With the prevailing and ever-increasing tendency of the present day to acquire wealth rapidly, many temptations are thrown in the way of the engineer. Individuals or corporations engaged in monopolizing natural or artificial advantages for selfish purposes, to the detriment of others, do not hesitate to seek the aid of the engineer in furthering their objects. They tempt him to close his eyes to questionable and reprehensible practices. The engineer who is the head of, or is employed in, a municipal or other government department, or who has charge of work executed under contract, is nearly always exposed to such temptation. Every kind of influence is brought to bear upon him to exercise the duties of his office or of his position for the benefit of some individual, party, or combination. It assumes every conceivable guise, and is frequently used in such an insidious manner that the unsuspicious mind is not aroused.

How often has not the engineer on municipal work been importuned to place the inspection of such work in the hands of some one whose sole qualification consisted in

nothing better than the possession of political influence, and who was expected to be not over scrupulous in carrying out the instructions of the engineer? In such case there must be but one issue, consistent with self-respect and with the reputation of the profession, and it is a credit to the craft to state that it is not often that such issue is not raised and carried out by the engineer, though it may often produce temporary embarrassment to himself.

The element of loyalty to duty, of absolute faithfulness to every honorable engagement, which is not infrequently ignored in many professional and business enterprises, must ever be a distinguishing characteristic of every member of this profession. No matter what may be thought, said, or done in any other walk of life, that much, at least, the engineer owes to his calling, which through its combined achievements reflects credit and reputation upon the individual. In whatever form his service is rendered, whether in an official or private capacity, it must be given with honesty of purpose.

The world must know that the engineer does not lend himself, his ingenuity, his skill, or his experience to aught but what is right, and that, having the privilege of declining, his acceptance of a commission means that he is not, knowingly, lending himself to any questionable undertaking, and that his sense of probity, his pride in his work, and his devotion to his profession rise above every other influence or consideration.

The engineer, therefore, must not regard his work only as the means for acquiring a competency, but he must bring to it an earnest enthusiasm which will pilot him safely past every temptation to ignore his duty. His sense of honor will guide him in avoiding errors, failures, and disappointments in his work, and cause him not to assume any obligations he is not qualified to fulfill, or which are at variance with professional propriety and dignity.

To his brother engineer he should always entertain the same candor, courtesy, and respect that he does toward the entire brotherhood; he should always be fair minded and honorable. His sense of justice and equity will never allow him for one instant to forget that he himself is not infallible, that there is often more than one way of solving a problem, and that the work of the "other" may be capable of as good results, with as high economy, as his own solution; nor will he forget that his fellow engineer has the absolute and unqualified right to receive the same consideration he would himself expect.

He will, with the innate spirit of a gentleman, honor and respect the opinion and judgment of his fellow engineer, if given in good faith, to the same extent that he values his own; for the argument and reasoning of the one may be as sincere and logical as that of the other, and may possibly be founded on as good or even better experience, the relative merits of which can only be determined by unbiased consideration. He should also recognize that the reputation of the individual is inseparably linked with that of the profession, that the honor and glory of one reflects upon the other, and that, therefore, by maintaining the standing and reputation of its members, he is but maintaining his own.

The respect and esteem which a community entertains toward any profession or its members is always in proportion to that which the members of such profession entertain toward one another.

Unfortunately, there are those who do not hesitate to presume upon the general confidence accorded by the community to any profession, and to exploit it or its reputation for purely personal profit and gain. In the other professions the law has been invoked to provide protection against the unauthorized acts and unprofessional practices of members or individuals whose dealings and transactions tend to reflect discredit upon their several occupations.

Happily, there has been no necessity for the enactment of any special statute to protect a community against imposition from the engineer or from one who claims to be a member of our profession, probably because his deeds and works speak for him, while his misdeeds advertise themselves with surprising rapidity.

The engineer is not infallible; he may make mistakes, and it would be remarkable indeed if he did not at some time err in his judgment; but, so long as he is conscientious, exercises every care, and exhausts all his resources in the performance of his obligations, it cannot be said that he is culpable or negligent in his duty. It is necessary, therefore, that he should always be circumspect and vigilant. That the engineer has recognized these obligations toward his profession is evidenced by his standing in the community to-day, and by the trust and confidence with which every material development has been committed into his hands.

It is not the object to applaud our own work, but to resolve that the engineer shall ever be found worthy of every trust, equal to every emergency, and imbued with the lofty spirit and noble purposes of the profession, with the understanding that it is his mission to study and utilize the elements and forces of Nature in such a way that they will become the agents through which he may contribute his share in the universal upbuilding of a higher civilization.

Though, during the brief period in which engineering has become recognized as a most important factor in this work, an advance has been made greater than all the wisdom of previous ages could conceive, it is probable that not much more than the portal of that temple of fame has been reached wherein the full knowledge of the occult forces and secrets of Nature yet lie concealed.

Enlisted in this glorious service, let the spirit of zeal and noble effort animate every engineer, and the lofty purposes of the profession spur him onward to become a worthy member thereof, bringing to it the ardor and enthusiasm of the artist, the earnestness and perseverance of the student, together with the genius to originate, and thus he will aid in raising to its highest point the standard of professional achievement.

With this thought, mindful of what has been accomplished in the past, and of the great possibilities of the future, I send you my sincerest greetings, and best wishes for an auspicious and memorable convention, and for the success and prosperity of every member of our profession.

A METHOD OF ESTIMATING STREAM DISCHARGE FROM A LIMITED NUMBER OF GAGINGS.

By J. C. STEVENS.*

In hydraulic engineering it frequently becomes necessary to make estimates of the discharge of a stream for stages at which no measurements have been made, hence the problem: Having given the gage heights for a season with two or possibly only one measurement of discharge, to develop a rating curve covering the entire range of recorded stages. This problem is frequently indeterminate and any solution is always subject to more or less error. However, cases arise where it is absolutely essential to make some sort of an estimate and for this purpose the following method has been found to give fairly reliable results.

The method involves the assumption that a function of the cross-section of the stream can be found to which the discharge is approximately proportional. By plotting the discharge as abscissas and this function as ordinates, a straight-line discharge curve is obtained which admits of ready extension to any stage not involving overflow of the banks. Where the latter condition obtains, the overflow portions must be treated separately.

The Chezy formula for discharge suggests a function of the cross-section to which the discharge is approximately proportional. This formula is

$$q = A\,v = A\,c\,\sqrt{r\,s}$$

where

q = discharge.
A = area of cross-section.
v = mean velocity.
r = hydraulic radius.
s = slope of water surface.
c = the Kutter coefficient.

If the discharge is considered a function of $A\sqrt{r}$, the formula becomes

$$q = (c\sqrt{s})\ (A\sqrt{r}).$$

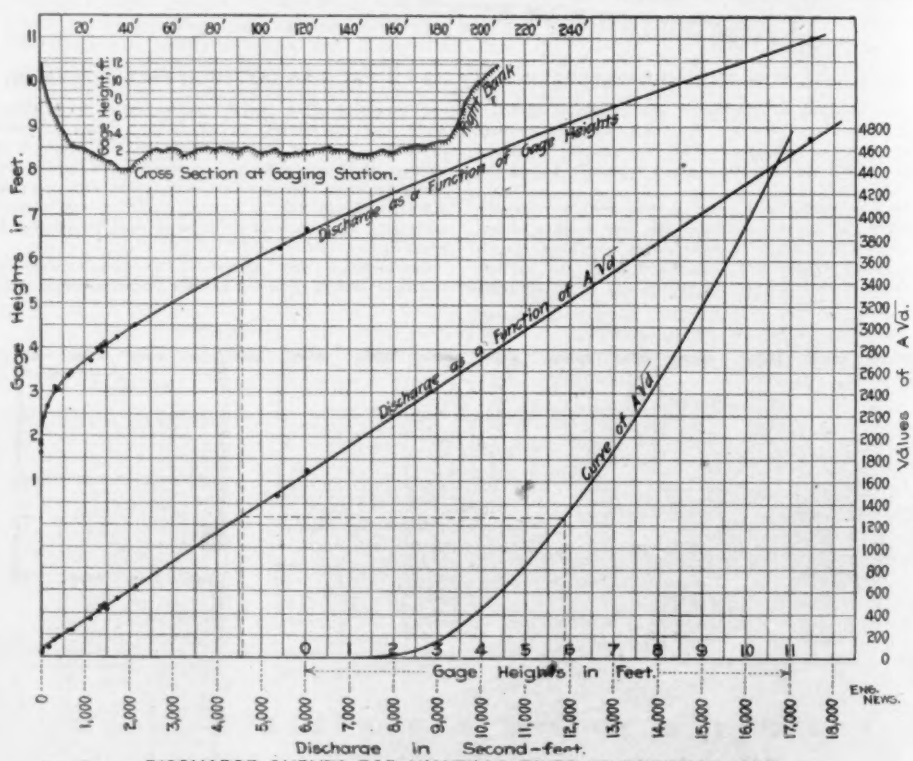
Whether or not this or allied formulas are of general applicability to rivers is of no moment in the present discussion. It is sufficient to note that for any particular point on a stream the quantity $(c\sqrt{s})$ may remain practically constant, hence the above expression represents a straight line if $(A\sqrt{r})$ be considered the independent variable. Experience has shown that the mean depth d can be substituted for the hydraulic radius, giving for the purpose not only just as reliable, but frequently better results, and has the advantage of being more readily determined.

If the bed and banks of the stream are composed of permanent material a single cross-section is sufficient for determining the value of $A\sqrt{d}$ for all stages, and a single measurement would theoretically determine the constant in the equation

$$q = K\,(A\sqrt{d}),$$

which is the basis of the method. Practically the method is not applicable to low-water conditions on account of the uncertain effect of the rapidly changing slope when the bed of the stream is not well covered with water. Therefore at least two measurements at different stages are desirable.

The accompanying diagram illustrates the method from an actual case, the Umatilla River at Umatilla, Ore. A number of others can be presented wherein the agreement is just as close.



DISCHARGE CURVES FOR UMATILLA RIVER AT UMATILLA, ORE.

(Based on Gage Height and on $A\sqrt{d}$.)

The bed of the Umatilla River at this point is solid basaltic rock and very rough, as the cross-section in the diagram will show. The discharge curve was developed by this method to a gage height of 9.00 ft. before the flood measurement of May 31, 1906, was made. This latter gave a discharge of 17,500 second-feet for a gage height of 11.00 ft., which when plotted falls almost exactly on the straight line extended.

The procedure is as follows: Plot the elevations

*Hydrographer, U. S. Geological Survey, Portland, Ore.

of the bed of the stream above gage datum and thereby obtain a cross-section. From the cross-section prepare a table giving widths, areas, mean depths, and values of $A\sqrt{d}$ for each foot or half foot of gage height. Widths may be scaled directly from the cross-section. The table of areas is quickly prepared by first computing the area for one gage height about midway of the range of stage; for increasing gage heights add successively the areas of trapezoids formed by successive widths and gage height interval, for decreasing gage heights subtract these successive areas.

After the table of areas has been prepared the quantities $A\sqrt{d}$, or $A\sqrt{\frac{A}{w}}$, where w = width, can be read directly with a slide rule. On cross-section paper draw the curve of $A\sqrt{d}$ using gage heights as abscissas, as shown in the diagram. After this curve is drawn the values of $A\sqrt{d}$ are no longer required. Lay off a scale of discharge as abscissas. To plot a discharge measurement, project from the horizontal scale of gage heights to the curve of $A\sqrt{d}$ thence horizontally to intersect the given discharge as indicated by dotted line. Points so plotted will generally conform to a straight line.

In the illustration the station rating curve is also shown, where the same scale of discharges is used, with gage heights as ordinates shown on the left.

The straight line marked "Discharge as a function of $A\sqrt{d}$" does not pass through the origin, for reasons above stated as to the effect on the constant c of the rapidly changing slope at low stage. Therefore when but a single measurement is at hand the line should be drawn to intersect the scale of $A\sqrt{d}$ at some point above the origin. This point has been found to correspond approximately to the gage height at which the mean depth of flowing water is between 1 and 2 ft.

In the case, frequently encountered, where there is ponded water at the gage height of zero discharge, the value of $A\sqrt{d}$ corresponding should be subtracted from the tabular values of this quantity before plotting. The discharge equation then becomes

$$q = K\,(A\sqrt{d}) - M$$

where M is the value of $A\sqrt{d}$ corresponding to zero discharge. The gage height for which the discharge is zero can be determined by a careful examination with levels or soundings of the bed below the gaging section. Even in this case the straight-line discharge curve will pass above the origin and should be treated as above outlined for conditions where ponded or "dead" water does not exist.

This method as described has been extensively used by the writer in the Columbia River District (Oregon and Washington) where discharge curves were insufficiently developed. It has been found to be practical of application, is not tedious, and gives better results than the use of logarithmic paper or other common methods of so-called discharge curve extensions. It is not infallible, however, and must be used with discretion.

PROPOSED AUXILIARY HIGH-PRESSURE FIRE PROTECTION WATER SUPPLY FOR HARTFORD, CONN.

An interesting report on a high-pressure water system for Hartford, Conn., has recently been submitted to the Common Council by the Presidents of the Boards of Fire, Street and Water Commissioners and the City Engineer, together with Mr. Ermon M. Peck, Consulting Engineer. The report was prepared for the committee by the two engineers. Besides outlining an auxiliary fire protection water supply for Hartford, the report contains a considerable amount of interesting and useful information on various supplementary systems built or proposed elsewhere.

The importance of adequate water supply for fire protection is emphasized in the opening part of the report by a tabulated list of great fires in the United States and Canada, beginning with the Savannah fire of 1820 and extending to and including the Baltimore and Rochester fires of 1904. The 45 fires listed destroyed property valued at $540,000,000.

We reproduce herewith a table in the report, showing the main particulars of the supplementary fire protection water supplies in use or proposed in 21 cities in the United States and Canada.

Another compilation of considerable interest given in the report is designed to show "the relationship between population and number of stories in the highest buildings in 56 cities in the United States and Canada." The table may be summarized as follows: Populations ranging from 14,000 to 20,000, highest buildings 4 to 7 stories; 25,000 to 37,000, 3 to 6 stories; 40,000 to 98,000, 4 to 10 stories; 100,000 to 290,000, 6 to 13 stories; over 300,000, 14 to 43 stories [the latter being the Singer Building extension now in process of construction in New York City]. In a general way, the figures in question are taken to indicate that for a population of about 200,000, which may be assumed as probable in Hartford 40 years hence, buildings of 12 stories might be anticipated; but Hartford with its present estimated population of 98,000 already has a building 10 stories high, and therefore appears to be in advance of its population class. In view of this and the character of the business interests of the city, the report states that perhaps buildings 15 to 16 stories in height may be expected.

In designing the proposed fire protection system, the length of hose necessary has been given more weight than the probable height of buildings. The system was therefore planned to limit the general hose length to 600 ft., and to 400 ft. in the case of the more important city blocks. A pressure of 300 lbs. was decided upon.

The area to be protected includes 1.14 sq. mi. of diversified topography. The higher portions of the area rise about 75 ft. above mean low water in the Connecticut River. To serve the whole of this area, 10.12 miles of 8 to 24-in. cast-iron pipe, ranging in thickness from ⅞ to 1⅞ ins., and giving factors of safety of 15.3 to 10.8, would be required. There is proposed for immediate construction a system embracing only 4.32 miles of mains, which would serve the principal business portion of the city. These mains would be supplied from a pumping station located on the west bank of the Connecticut River, in Riverside Park, near the present water-works pumping station.

For power and pumping plant, two estimates are presented, one involving the use of gas engines and the other steam turbines and turbine pumps. The pumps for this project would include seven units (one for reserve) of 1,800 gals. per min. capacity. The gas engines would be of the horizontal, four-cycle, twin tandem, double acting, four-cylinder type, direct-connected to a vertical, double-acting triplex pump. Producer gas would be used. The estimated construction cost for this project would be $378,000 for the power station and $195,000 for the distribution system, making a total of $573,000. The construction cost of the steam-turbine and turbine-pump project would be $258,000 for the power plant, or a total of $453,000—the distribution system being the same in this as in the other project. The maintenance and operating charges for the gas-engine plant would be $65,667 a year, as against $87,904 for steam turbines, or $22,237 in favor of the former. The estimated cost of a power plant and distribution system of sufficient size to serve the whole instead of the restricted area would be $796,000.

The gates on the distribution system would be of the double-disk type, tested to 500 lbs. per sq. in. No gate larger than 20 ins. would be used, a few gates on the 24-in. line being set with 24 × 20-in. reducers on either side.

Fire hydrants of the gate type are proposed, each with four 2½-in. outlets and 8-in. barrels. Each outlet would have an independent gate. Hydrants for street flushing purposes would have one 2½-in. outlet and 6-in. connection with the mains. The hydrant spacing was fixed at 150 ft. in the congested district, decreasing to 200 ft. and finally to 300 ft.

LUMBER AND TIMBER PRODUCTS OF THE UNITED States are the subject of a bulletin (No. 77) issued by the U. S. Bureau of the Census. A comparative tabular summary for the decades from 1850 to 1900, inclusive, and for the year 1905, shows an increase in value of lumber and timber products of from $60,413,000 in 1850 to $555,197,000 in 1900 and $580,023,000 in 1905. The number of establishments included in these summaries was 18,769 in 1850, 23,053 in 1900, and 19,127 in 1905. The average number of wage-earners, not including salaried officials, clerks, etc., was 55,810 in 1850, 413,335 in 1900, and 404,626 in 1905. The census of 1905 "was confined to merchant mills and timber camps of similar magnitude, thus excluding the custom mills and petty establishments in all branches of the industry." So far as practicable, the figures for the census of 1900 have been revised, for purposes of comparison, to correspond with those for 1905, but no such revision was attempted for earlier years. It seems probable, we may interject, that a large number of the establishments included in the earlier censuses, particularly the one for 1850, were of such a character that they would not have been enumerated under the rules followed in 1905. It is interesting to note that the number of establishments and also the number of wage earners fell off materially between 1900 and 1905. The number of salaried officials and clerks, however, increased from 14,238 to 18,485, and their salaries from approximately $12,500,000 to $20,000,000. The earnings of wage-earners increased from $148,000,000 to $183,000,000, notwithstanding a decline of nearly 9,000 employees from 1900 to 1905. In 1880 there were 5,967 children under 16 years of age reported as at work; in 1890, 3,268; in 1900, 3,549; while in 1905 the number had fallen to 2,506.

FIRE PROTECTION IN 21 CITIES OF THE UNITED STATES.

City	Estimated Population	Date of Installation	Source of Pressure	Gallons per minute	Maxi'm Pressure lbs.	Lineal ft. of Mains	Sizes of Mains in Inches	No. of Hydrants	Total Cost of System	No. of Acres	Cost per Acre	Connection with Buildings	Effect on Insurance Rates
Atlantic City	40,000	Proposed	1 Station Electric Turbine Pumps	7,000	225	38,590	8-14	82	$ 187,272	306	$ 612.		
Baltimore	575,000	Proposed	Pumping Station			75,900	10-20		* 397,999	360		Standpipes on Buildings	
Boston	620,000	1898	Fire-boat	6,000	200	4,700	12	14	30,080	65	463.		
Brooklyn	1,400,000	Construc'g	2 Pumping Stations Electric Turbine Pumps	32,000	300		8-20		1,384,500	1420	975.		
Buffalo	420,000	1897	3 Fireboats		300	12,756	12						Reduction of 30 cts. per $1000
Chicago	2,100,000	Proposed	1 Station Gas Triplex Pumps	30,000	300	268,900	8-36	850	3,203,480	1280	2503.	No Open Connection	Reduction of 25% assumed
Cleveland	480,000	Construc'g	To have Pumping Station At present 2 Fireboats	10,000	300	32,524	8-20	96	* 170,000	338		May have Connection with Auto. Sprinklers	Reduction of 50 cts. per $1000 proposed
Coney Island		1905-6	1 Station Gas Triplex Pumps	3,600	150		8-16		90,000	147	612.		Reduction of 25%
Detroit	380,000	1893	2 Fire-boats	10,000	210	25,831	8-10	95		356	135.		Probably has prevented an increase
Fitchburg	33,000		Gravity †		180	28,250	8-16		50,000	346	144.	Boiler Feed, Elevs and Sprinklers	Prevented an increase
Hartford	98,000	Proposed	1 Station	10,000	300	53,430	8-24	198	796,277	731.3	1089.	No Open Connection	"
Lawrence	75,000	1906	Gravity †		134	10,200	10-12	39		120			No Change
Milwaukee	340,000	1889	3 Fire-boats	15,000	250	45,717	6-12	183		630			10% Reduction
Newark	290,000	1905	Gravity	3,500	165	15,000	20-30	52	135,000	303	446.	Some Connections	10% Reduction
New York (Manhattan)	2,100,000	Construc'g	2 Stations Electric Turbine Pumps	30,000	300		12-24	1200	3,950,400	1430	2763.	Water Curtains provided for	No Change
Philadelphia	1,500,000	1903	1 Station Gas Triplex Pumps	9,100	300	35,300	8-16	166	700,000	512	1367.	None on or in Buildings	Penalty of 25% removed ‡
Providence	200,000	1897	Gravity	3,672	116	29,409	12-24	89	143,136	358	400.	5 Automatic Sprinklers	No Change
Rochester	185,000	1874	2 Stations—Elec. Tur. P'p Steam Tur., Tur. Pump	9,000	140	102,960	4-20					Some Connections	Grand Reduction
Toronto	215,000	Construc'g	1 Station Electric Turbine Pump	14,000	300	40,000	8-20		500,000	287	1742.	Considering Connection	Uncertain
Winnipeg	110,000	Construc'g	1 Station—Gas Producer, Gas Eng., Triplex Pumps	10,800	300	15,840	8-20		650,000	275	2364.	Connection with Automatic Sprinklers	Uncertain
Worcester	138,000		Gravity †		165	100,320	8-30			1380		Elevators	No Change

* Exclusive of Pumping Station and Equipment.
† System consists of extensions of pipes from high service into district covered by low service.
‡ Board of Fire Underwriters have voted to reduce rates to the amount of 10 cents per $100.—A total of $40,000 if extensions costing $120,000 are made to the system.

METHODS OF DEEP-WELL PUMPING.

At a meeting of the Western Society of Engineers held in Chicago on June 5, Mr. C. B. Burdick presented a very interesting paper on "Methods of Pumping Deep Ground Water." After a review of the principles of well-flow, the utilization of deep-well water supply, and the testing of wells, the subject of pumping was taken up. Reciprocating pumps are adapted to small quantities and moderate lifts, and may be single or double acting, or with two plungers (one above the other). The intermittent starting and stopping of the water column causes an extravagant consumption of power and is hard upon the machinery, but it is partially overcome by the use of the differential plunger, with which the column is only partly brought to rest. The air-lift dates from 1797, and American patents were issued to Capt. James B. Eads in 1870, J. P. Frizell, in 1880, and Mr. Pohle, in 1892. The device did not attain commercial importance until Mr. Pohle's investigations were made public. The author referred to the fact that the mechanical principles of the air-lift are not clearly known, and stated that the best explanation was given in Engineering News of June 8, 1893. In the discussion, Mr. D. W. Mead stated that a comprehensive investigation of the principles and operation of the air-lift is to be made in the hydraulic laboratory of the University of Wisconsin. Particulars were given of numerous tests, and it was stated that the efficiency of the air-lift as a pump, exclusive of the compressor, ranges between 25% and 40% under favorable conditions and for medium lifts.

Where a method is required of greater capacity and efficiency than the reciprocating pump or the air-lift, as in the development of ground water supplies for the larger cities, a pump shaft or well may be sunk and tunnels driven laterally to connect with the various wells. The tunnel is usually considerably below the ground-water level. In the system built at Memphis, Tenn., by Mr. T. T. Johnston, the shaft is 80 to 90 ft. deep and the water is discharged directly into the tunnels. High-duty vertical Worthington pumps are used. In the system built at Rockford, Ill., by Mr. D. W. Mead, the tunnels are 95 ft. below the surface and contain suction pipes connecting the wells with single-stage centrifugal pumps installed at the bottom of the shaft and driven by rope transmission from vertical engines on the surface. A new type of pump which is of special interest and has already attained an important position in deep-well work is the high-speed centrifugal pump which is mounted on a vertical shaft and inserted within the well hole. Particulars as to this method of deep-well pumping, taken from Mr. Burdick's paper, are given below.

In reviewing the methods of pumping already noted, Mr. Burdick stated that for low lifts and small quantities the deep-well reciprocating pump has the field, and will probably continue to be used for estates, institutions and villages. For the air-lift there is a field entirely apart from the pumping of water supplied, as its lack of moving parts in contact with the fluid handled makes it specially adapted to the pumping of chemicals of corrosive nature. It is capable of multi-stage application where space is available, and thus a deep submersion can be avoided. This fits it for mine draining and like operations, and Mr. Mead stated that it is to be used for the former purpose in unwatering small mines in Wisconsin. It will probably continue to be used in water-works installations where the highest economy is not necessary. A number of plants have recently been installed for emergency fire service, and for such use it has many advantages. With sufficient power, there is no device capable of drawing a larger supply from a hole of a given size, even at considerable lifts. In many cases where this pumping device has been discarded as being extravagant in fuel, its lack of economy can be traced to unintelligent operation. It has suffered with other pumping devices by the receding static ground-water levels in the Middle States. While it is a simple matter to alter the air-lift pump proper for increasing lifts, the machinery for the air compression cannot easily be so altered, the greater lift necessitating greater pressures and volumes for economical results.

The shaft-and-tunnel method is applicable only to special cases, but where conditions will warrant its use it is capable of the highest coal economy of any machine used in deep-well pumping. In most cases this saving in fuel must be more or less offset by a heavy interest charge, as the underground construction is more or less uncertain and expensive. A plant of this kind should not be adopted without most careful study of the local underground hydraulics (past, present and future), as it cannot be altered easily in accordance with modifications that may be found desirable after the plant is built.

Vertical-shaft high-speed rotative pumping machinery of the centrifugal type already occupies an important place in the deep-well pumping field, and it is specially adapted for pumping considerable supplies from deep sources. The high rotative speed is favorable for plants where electricity is the source of power. Its connection to the steam engine will be somewhat awkward (although not seriously lacking in efficiency) until a vertical-shaft steam turbine in units of medium size is available. While somewhat lower in fuel economy than the shaft-and-tunnel method, it has the advantage of a smaller interest charge. It has a further advantage in that it is probably more adaptable to changing underground conditions than any other deep-well pumping device capable of the same duty. It is practicable to so design these pumps that they may be depressed upon occasion and adapted to higher lifts without increased speed by the addition of impellers.

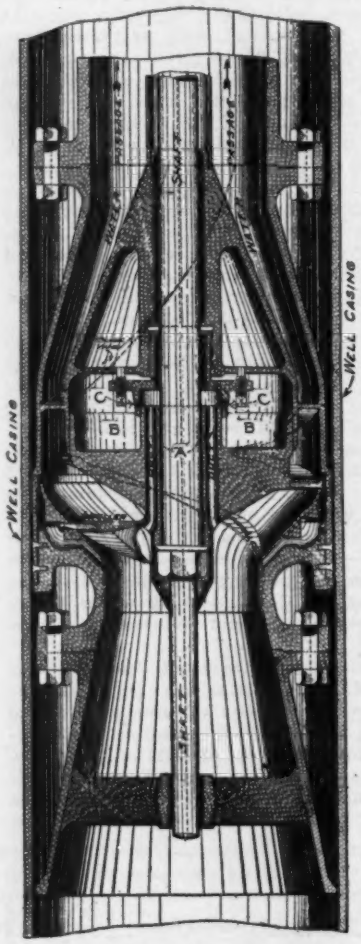


Fig. 1. Section of Deep-Well Centrifugal Pump.

John W. Alvord, M. Am. Soc. C. E., Chicago, Designer.

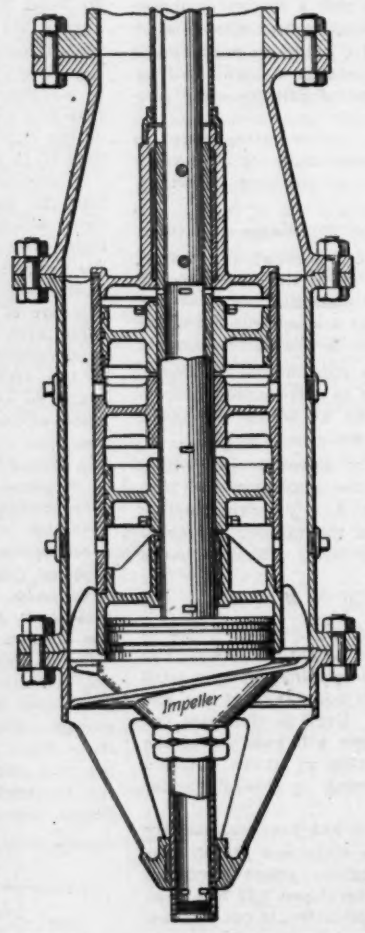


Fig. 2. Deep-Well Centrifugal Pump for High Lifts.

DEEP-WELL VERTICAL-SHAFT CENTRIFUGAL PUMPS.

A new pump is entering the deep-well field, and while it seems too much to expect that it will rival the high-duty reciprocating machines, applicable to the lower lifts of the shaft-and-tunnel-method, it has already assumed an important place. The writer refers to high-speed vertical shaft centrifugal pumps of such diameter that they can be set in bored or drilled well holes. It is believed that the earliest application of this device was made in the improvements to the water-works of Moscow, Russia, completed in 1900. The plant was described by Mr. N. T. Simin, Chief Engineer, in the "Proceedings" of the American Water Works Association for 1901. The pump was designed and built by the Forest firm of Paris. Each pump, as installed is accommodated in a 16-in. well, and at 1,440 r. p. m. lifts 812,500 U. S. gallons per day. The lift under which they operate is not specified, but, judging from statements in the paper, is about 50 ft.

In 1902, Mr. John W. Alvord, M. Am. Soc. C. E., in a report to the Chicago Clearing & Transfer Co. upon the development of a large ground-water supply at its proposed plant at Clearing (near Chicago), called attention to the possibilities of this means of pumping. At that time no device of this kind had been built in America. By request of the company, Mr. Alvord prepared a design of an experimental pump, which was constructed under his direction. The pump was so designed that various forms of impeller could be tried, and in 1902 the pump, equipped with the best impeller, showed an efficiency of 50% when operating at 1,640 r. p. m. and discharging 835 gals. per minute against a head of 38 ft. The experimental pump had one impeller only, and was so designed as to be accommodated in a 12-in. hole. The test was under the direct charge of Mr. M. E. Shire, engineer for the company. Owing to reasons entirely apart from the water supply, the construction at Clearing has not yet been carried out. The experimental pump has been recently turned over to Prof. D. W. Mead, of the University of Wisconsin, who has made a series of tests with various forms of impeller, which form the subject of a bulletin to be issued shortly by the University.

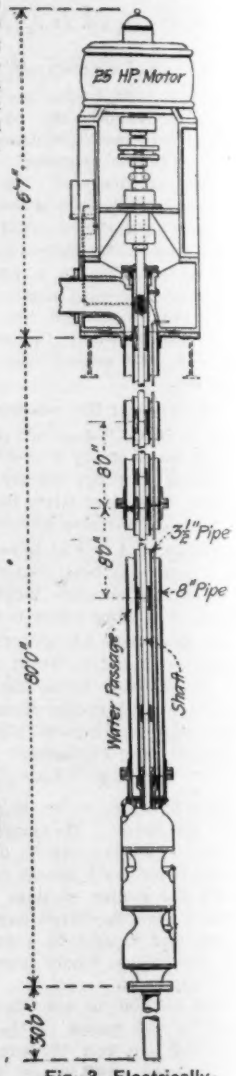


Fig. 3. Electrically-Driven Deep-Well Centrifugal Pump at La Grange, Ill.

Byron Jackson Machine Works, Oakland, Cal., Builders.

The successful operation of a device of this kind, at high speed, cannot be accomplished without proper provision for handling the down thrust; and the balancing device of Mr. Alvord's pump was one of the most satisfactory features of its operation. Its principle, like most means of balancing, depends upon the head of the

discharge water entering around the edge of the impeller, and applying its pressure to the under side of the same. The balancing chamber immediately above the impeller has the office of relieving the pressure from above so that the head below the impeller can act.

It will be observed in Fig. 1 that a duct, A, in the shaft connects the balancing chamber, B, with the suction side, and that the entrance to this duct is controlled by a port, C, that is opened and closed by a slight fall or rise of the impeller and shaft. By this arrangement, as the pump comes up to speed, pressure is produced in the discharge and (by leakage) under the impeller. By the proper apportionment of areas, this pressure tends to raise the impeller and close the port, in the balancing device. The leakage into the balancing chamber from the discharge passage causes the pressure to rise in the balancing chamber in sufficient amount to overcome the up-thrust. In the test it was found that as the pump came up to speed the shaft was lifted about 1/16-in., and rode clear of the balls in the ball thrust bearing provided at the top of the shaft. Fig. 2, taken from the patent drawings, shows this device as it might be applied to very high lifts, the number of balancing chambers being multiplied. The pump is capable of compounding, as is now done in centrifugal pump practice for high lifts. By increasing the number of impellers, high lifts can be accomplished at medium speeds.

At about the time that Mr. Alvord was making his plans the subject seems to have been taken up by Mr. Byron Jackson, of San Francisco, a manufacturer, who has done some creditable work in centrifugal pumping. His company is believed to have been the first to place this type of machine upon the market. The pump, now in operation in several water-works plants, is in many respects similar to that of Mr. Alvord. The first installation was made under the advice of Professor Mead at the Pabst Brewery at Milwaukee. This pump is a five-stage machine, and is accommodated in a 15-in. hole. It is designed to lift 700 gals. per minute against a net head of 220 ft. The speed of the shaft is 1,300 r. p. m. and the pump is engine driven, a twisted belt transmitting the power. The lift at present is 150 ft. Steam cards are said to indicate an efficiency from engine cylinder to water delivered of 56%. It is probable that this means not less than 65% pump efficiency. A similar installation has been operating at Waterloo, Ia., since 1905.

An interesting electrically-driven water-works plant just completed at La Grange, Ill., includes centrifugal pumping machinery for the development of a deep ground-water supply, and subsequent pumping by a second set of pumps into the distribution system of the city. The new electric plant replaces a steam-driven water-works in which the air lift was used for pumping the well supply. The electric current is furnished by a large generating station at Maywood, some four or five miles distant, from which a number of suburban water and light plants are to be supplied. Two wells formerly drilled furnish the supply. They are located about 100 ft. apart. Their dimensions previous to the improvements were as follows:

Well No. 1		Well No. 2	
Diam.	Depth.	Diam.	Depth.
6 ins. to	40 ft.	8 ins. to	130 ft.
5½ ins. to	810 ft.	6¾ ins. to	1,364 ft.
5 ins. to	1,310 ft.	6 ins. to	2,045 ft.
4 ins. to	2,024 ft.		

The wells derive the major portion of their supply from the Potsdam sandstone formation. Tests preliminary to the installation showed the static ground water level to be 26 ft. below the ground surface. The wells are about equally efficient in regard to water delivery, and furnish when operated separately 360 gals. per min. under a 40-ft. drop, corresponding to a water level of 66 ft. below the ground surface. Operating together the combined delivery was 490 gals. per min. at the same depression in water level as before. Before installing the pumps the wells were reamed out for a depth of 120 ft. to a diameter of 16 ins., and a 15-in. internal diameter casing placed in each down to rock about 30 ft. below the ground surface. Fig. 3 shows one of the two units installed. The capacity is 350 gallons per min. with 100 ft. head and at 1,120 r. p. m.

The pump is driven by a 25-HP. Westinghouse three-phase, 440-volt induction motor running at 112 r. p. m. It is connected to the shaft by a flexible leather link coupling. The weight of the armature is carried by a separate thrust bearing in the motor casing. A portion of the down thrust is taken by balancing chambers of the Jackson type just above the pump runners. It is evidently considered that this balancing arrangement does not have sufficient elasticity, for an additional water step-bearing is provided, on the pump head at the ground level. Until the pump comes up to speed the shaft is carried on a roller thrust bearing on the pump head. In the drawing the well casing is not shown; the pump hanging free and entirely independent of it. The water is discharged through the annular space between the 8-in. uptake pipe and the 3½-in. pipe which encloses the driving shaft. The shaft is supported by babbetted bearings at intervals of 8 ft. Each alternating bearing forms a coupling for the 3½-in. pipe, and these bearings are centered and held firm by means of three jam-nuts equally spaced around the combined bearing and coupling. Provision is made for giving the bearings and impellers a small amount of oil, but since the first few weeks of operation no oil has been supplied except to the impellers, the water lubrication apparently being sufficient. Each pump is now working, when operated alone, under about 75 ft. head, friction not included, and delivers 405 gals. per min.

The preliminary run seems to indicate that the pump efficiency is close to 50% and the motor efficiency 85%. The unit in well No. 1 has now been in constant operation for about eight months. The unit in well No. 2 has just been installed. The pump operates very nicely. When in the room with the pump, one has almost to stand directly in front of it to perceive that it is running. The entire pumping plant was designed and built by the Byron Jackson Machine Works, Oakland, Cal. The plant was designed and supervised by Sargent & Lundy, mechanical and electrical engineers, of Chicago, under the advice of the writer and his associate (Mr. Alvord).

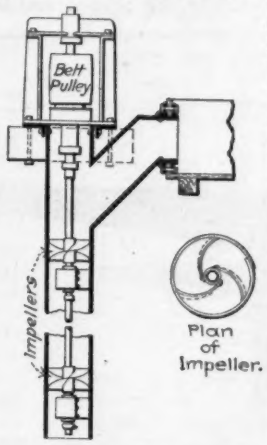


Fig. 4. Deep-Well Centrifugal Pump.
P. K. Wood, Los Angeles, Cal., Designer.

Reference must be made to the propeller pump designed and built by Mr. P. K. Wood, of Los Angeles, Cal. It is believed that the use of this pump antedates the Moscow installation. Fig. 4 is an illustration of this pump, which sufficiently explains its method of operation. The propellers are shown equally spaced, the lowest impeller, of course, being below the static water level of the well. Mr. Wood discovered that these propellers may be compounded, and when bunched at the bottom of the shaft the result is the same as by the arrangement shown. Two installations have been made in this vicinity, the first at Batavia, Ill., where a pump is driven by a Pelton water-wheel, and the second at Madison, Wis., where the pump is electrically driven. Prof. Turneaure tested one of these pumps at Madison previous to the permanent installation of the city water-works, and reported the overall efficiency of the driving electric motor, belt and pump at 40%. He estimated that, allowing for motor and belt, the pump efficiency is about 50%. With some improvements in its mechanical details this pump should give a good account of itself.

THE FIFTEENTH ANNUAL CONVENTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

(Concluded from page 47 of last week's issue.)

After a meeting of the Council at 9 o'clock Tuesday morning, July 2, the second regular general session was opened at 9.30. Prof. Frank H. Constant, of the Department of Structural Engineering, University of Minnesota, gave a paper on "The Six-Days System at the University of Minnesota," and Fred A. Fish, Associate Professor of Electrical Engineering at the University of Iowa, "The Work of the Freshman and Sophomore Years of the Engineering Courses." The two papers—mainly devoted to questions of routine—were discussed together.

Prof. Geo. R. Chatburn, of the Chair of Applied Mechanics and Machine Design, University of Nebraska, presented "A Combined Cultural and Technical Engineering Course" and a paper by President F. W. Atkinson, of the Polytechnic Institute of Brooklyn, "Technical Education with a View to Training for Leadership" was read by Secretary Magruder.

Too much time necessary for such a course was the main objection to Prof. Chatburn's paper; and the utter impossibility of "picking winners" at the formative period of the embryo engineer's career the main objection to the second. One member suggested that the selection of a few "stars" for special nurture and hot-house treatment, for training for future generalship, would be apt to induce symptoms of enlarged cranium in all but the most steady; Prof. Franklin, of Lehigh, advocated letting men fight out the leadership question among themselves; Prof. Cooley (U. of Mich.) said succinctly, "Leaders are born, not made."

At the fourth session, Tuesday afternoon, July 2, the first paper was "The Work of the Dean of a School of Engineering," by Louis E. Reber, Dean of the Engineering School, Pennsylvania State College. It was read in his absence by Prof. A. J. Wood, of that institution.

Prof. Franklin, of Lehigh University, read two papers in succession—"A Course in Physics for Engineering Students" and "The Teaching of Elementary Mechanics," the latter being partly by his assistant, Prof. Barry MacNutt.

The discussion of these papers was particularly in regard to a getting together on methods by the various institutions, and also regarding the pros and cons of the use of text-books.

This session was cut short at 4 p. m. for adjournment to a reception on the floor below, given by the ladies of the Case faculty under the leadership of Mrs. Howe, for the visitors.

The next session of the convention looked at first glance like a social event purely and simply; but it proved one of the most entertaining technical sessions held. At 7.30 Tuesday evening the trustees and faculty of the Case School of Applied Science entertained the members of the Society at a dinner, at the University Club, 2738 Prospect Ave.

After the gustatorial side of this session had been satisfactorily attended to, President Howe, of Case School, as toastmaster, introduced Mr. J. N. Henderson, President of the Board of Trustees and one of Cleveland's leading attorneys. Mr. Henderson made a brief address, and the toastmaster then introduced Mr. Worcester R. Warner, of the firm of Warner & Swazey, as the practicing engineer most intimately associated with Case School. President Jackson, of the Society, then delivered his presidential address—"The Relations of Engineering Schools to Polytechnic Industrial Education." After the President's address the members were invited to discuss the subject informally, and did so until a late hour. This important and often neglected phase of engineering education—the training of the corporals and sergeants of industry, foremen and superintendents—has a warm advocate in Prof. Jackson. The discussion of his address developed many more.

It was brought out in the discussion that the recently inaugurated night courses at Columbia had at once developed a large attendance, among just such industrial sub-officers, and "privates" as well. Prof. Williston, of Pratt Institute, Brooklyn, gave some figures regarding the tremendous increase in attendance at the night engineering courses there, and described almost with pathos the necessary turning away of scores of applicants through lack of facilities for handling them; he closed his discussion with an earnest plea for increase in the facilities for this secondary engineering education at our existing institutions.

At the opening of the session on Wednesday morning, July 3, at 9.30, nine new members were elected. Charles S. Gingrich, of the Cincinnati Milling Machine Co., for the manufacturers, and Herman Schneider, Dean of the College of Engineering of the University of Cincinnati, for the university, described "The Cooperative Engineering Course at the University of Cincinnati." Prof. Schneider's paper is reprinted in this issue.

The report of the Committee on Industrial Education was presented by its chairman, Dean Calvin M. Woodward, of Washington University (St. Louis).

The session of Wednesday afternoon was devoted in large part to the methods of apprentice instruction by the large industrial concerns. Messrs. A. G. Wessling, Assistant Engineer of the Allis-Chalmers Co., and Chas. E. Downton, Foreman of Apprentices, Westinghouse Electric & Mfg. Co., each presented descriptive papers. Charles F. Scott, Consulting Engineer of the W. E. & M. Co., had prepared a paper entitled "The Technical Graduate and the Electrical Manufacturing Company," and being called away suddenly his paper was read by the Secretary.

Such courses, the discussion brought out, bore the hearty endorsement of the universities and

colleges;. cooperation between the colleges and the industrial companies and practicing engineers will aid in the articulation of the college training work with the practical work after graduation. The outcome of this discussion was the adoption of the following resolutions:

WHEREAS, It is desired to make a comprehensive study of the objects and the utilities and the correct ideals of engineering education; therefore be it

RESOLVED, That the Society for the Promotion of Engineering Education hereby invite the respective governing boards of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society for Chemical Industry each to appoint two members to become delegates, composing part of a joint committee on engineering education, which committee shall consist of the said two members appointed from each of the aforesaid societies, or the delegates of such societies as accept this invitation and appoint their respective delegates, and three members appointed as delegates by the Society for the Promotion of Engineering Education; and in pursuance hereof be it further

RESOLVED, That the Council of the Society for the Promotion of Engineering Education be hereby directed to appoint three members as delegates to the membership of the said joint committee on engineering education; and further

RESOLVED, That the duty of said joint committee on engineering education shall be to examine into all branches of engineering education, including engineering research, graduate professional courses, undergraduate engineering instruction, and the proper relations of engineering schools to the secondary industrial schools or foremen's schools, and to formulate a report or reports upon the appropriate scope of engineering education and the degree of cooperation and unity that may be advantageously arranged between the various engineering schools; and that the said joint committee be requested to make a report of progress to this society within a year, and to make its final report to this society within two years.

The significance of this movement is great; it will tend to develop the relations between those who educate and those who use engineers more than any step that has heretofore been taken, if the large national engineering societies respond in a kindred spirit; and we do not see why they should not. At the meeting of the American Institute of Electrical Engineers at Niagara Falls, it was voted to appoint a committee on engineering education; the mechanical engineers have one already; the modification of these committees, each working independently, to a joint committee basis could not fail to produce excellent results.

Other papers presented at the Wednesday afternoon session were "Some Class-room Experiments in Mechanics," by Prof. James E. Boyd (Ohio State U.), "Some Debatable Questions Concerning the Course in Mechanics," by Prof. Edw. R. Maurer (U. of Wis.), and "The Teaching of Mechanics to Engineering Students," by Prof. Walter Rautenstrauch (Columbia). Prof. Geo. W. Bissell described "The Engineering Experiment Station at Iowa State College," and "The Illinois Engineering Experiment Station," by Prof. Lester W. Breckenridge (U. of Ill.) was read by Secretary Magruder.

An overflow session was called for Wednesday evening at which the following papers were presented: "Loose-leaf Notes for Laboratory Use," by Prof. Chas. H. Benjamin (Case School); "The Teaching of Machine Design," by Prof. Jas. D. Hoffman (Purdue); "Examination Data," by Prof. Rosser D. Bohannan (Ohio S. U.); "The Technical and Pedagogic Values of Examinations," by Prof. H. H. Norris (Cornell); "Descriptive Geometry:—Its Importance in the Engineering Curriculum," by Prof. Otis E. Randall (Brown); and "The Honor System of Examinations," by Dean William H. Schuerman (Vanderbilt). These were all discussed considerably, and it was a late hour before the meeting was adjourned.

OFFICERS.

At the session Wednesday morning the following officers were elected for the ensuing year:

President, Charles S. Howe, Case School of Applied Science; First Vice-President, Clarence A. Waldo, Head Professor of Mathematics at Purdue University; Second Vice-President, Dean Wm. G. Raymond, of the University of Iowa; Secretary, Arthur L. Williston, Director of Department of Science and Technology, Pratt Institute, Brooklyn; Treasurer, William O. Wiley, of John Wiley & Sons, Publishers.

There was an attendance of more than 75 members at this convention, representing a total of 18 states. Members from states as far away as Montana and Washington were in attendance.

Columbia University, New York City, has been suggested as a probable place for next year's meeting.

SOME NEW BASCULE BRIDGES.

The use of the bascule type of drawbridge is increasing to a very marked extent, and a number of important structures of this kind are now under construction. In the present article we describe some recently completed bascule bridges of different designs.

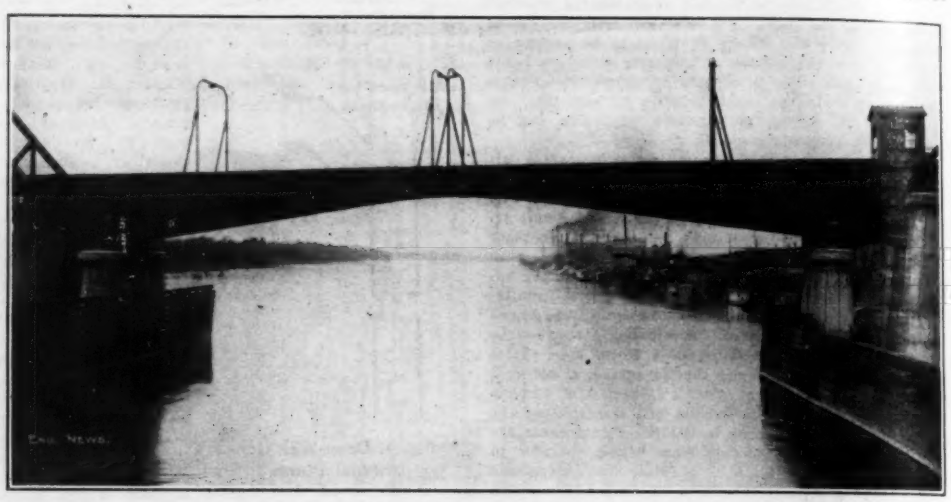


FIG. 1. BASCULE BRIDGE (RALL TYPE) OVER THE ILLINOIS RIVER AT PEORIA, ILL.: ILLINOIS INTERURBAN TRACTION SYSTEM.
Strobel Steel Construction Co., Chicago; Builders.

RALL TYPE OF BASCULE BRIDGE, PEORIA, ILL.

The interurban railway lines of the Illinois Traction System enter the city of Peoria, Ill., by a long steel bridge over the Illinois River, including four riveted through-truss spans of 142 ft. 10 ins. c. to c. of piers, and a bascule deck span of 141 ft. over the channel, giving a headway of 10 ft. 6 ins. above high water. This bascule span is of the Rall type, in which the pivot or point of support moves backward from the opening as the leaf rises. The first bridge of this type was a double-track single-leaf structure of 26 ft. 3 ins., crossing the Miami & Erie Canal at Delphos, O. This was described in Engineering News, May 25, 1905. The Peoria bridge is the second of this type, and is a single-track double-leaf structure; it has no tail pit, owing to the height of the bridge above the water. It is carried at each end by a steel framework resting on the end pier of the fixed span and another pier in advance of this; the piers being 10 ft. c. to c. The bridge was designed by Mr. Ralph Modjeski, M. Am. Soc. C. E., as engineer for the McKinley Syndicate which owns the railway. The contract for the superstructure was let to the Strobel Steel Construction Co., of Chicago, and the bascule span was designed by this company,

Fig. 2. Bascule Bridge Open.
(Note that the leaf has rolled back upon the track girders)

which is owner of the Rall patents. The concrete piers were built by the McArthur Brothers Co., of Chicago. Fig. 1 is a view of the completed bridge, and Fig. 2 shows one span raised; it will be seen that this leaf has also rolled back from the opening.

The general arrangement of the mechanism is shown in Fig. 3. The bridge is supported at its center of gravity by a shaft A, having at each end a roller B, which rides on the horizontal track girder C. As the bridge opens and rotates around this shaft, it is made to roll backwards by means of a pair of swinging struts D, connected to the counterweighted heel of the girder and to the pier by pins E and F respectively. When the bridge is closed, the girders are seated on pin F (on the pier) by means of a pedestal G attached to the bottom chord. In this way the rollers are raised clear of the tracks and relieved of their load, the weight being transmitted directly to the pier. The bridge is operated by the pinion H, which is driven by gearing from an electric motor, and engages with a rack on the bottom face of the operating strut J. As the operating strut pulls the leaf up, it also causes it to travel back upon the track girder, the movement being regulated by the swinging struts already mentioned. The track girders are pairs of 24-in. I-beams, with top and bottom cover plates, and track plates on top. There is a 25-HP. motor to each leaf, and the bridge can be opened or closed in about 45 seconds. The operation of the tail lock and rail locks for both leaves will increase the total time to about two minutes. The Peoria bridge is built for an assumed continuous loading of 75-ton cars 45 ft. in length.

Four railway bridges of the Rall type are now being built by the Strobel Steel Construction Co. at Indiana Harbor, Ind. Two of these are for the Lake Shore & Michigan Southern Ry., and the others for the Baltimore & Ohio Ry. and the Pennsylvania Lines. They are double-track, single-leaf, through bridges of 86 ft. span between supports. In the case of these bridges and the Peoria bridge, lump sum bids were submitted, and the contracts awarded to the lowest

bidder. For this type of bridge the following advantages are claimed: (1) The length of span is a minimum, and equal to the distance between centers of channel piers; (2) the length of travel is a minimum, the tail end just clearing the channel pier when the bridge is fully open; (3) the shop work and the operating mechanism are simple, and the carrying wheels can easily be removed or repaired, as the bridge does not rest upon them when closed; (4) the type is very economical, both as to quantities and cost.

SCHERZER TYPE OF BASCULE BRIDGE: PEORIA, ILL.

The new city bridge across the Illinois River at Peoria, Ill., has five reinforced-concrete arches of 110 ft. and 125 ft. span, and a channel span of 135 ft. consisting of a double-leaf bascule on the Scherzer system. This span is 142 ft. c. to c. of main bearings, and has deck girders with the bottom chords curved so as to harmonize in appearance with the concrete arch spans. Each leaf is operated by a 52-HP. electric motor using three-phase, 60-cycle current at 220 volts. The usual operating strut is dispensed with, and the train of gearing drives two operating pinions which engage with horizontal racks carried by a steel framework on the pier. The pinion shaft is located at that point of the leaf which travels in a straight line as the leaf swings up or down and at the same time rolls backward or forward upon its segmental heel.

This bridge has a 25-ft. roadway and two 5-ft. sidewalks. The channel piers are large, forming the abutments of the adjacent arch spans and also carrying the bascule span with the operating machinery, etc. The tail pits are formed in these piers. The arches are reinforced on the Melan system, and the fixed part of the structure was designed by the Concrete-Steel Engineering Co., of New York, and built by the Marsh Bridge Co., of Des Moines, Ia. The bascule span was designed by the Scherzer Rolling-Lift Bridge Co., of Chicago, and built by the Penn Bridge Co., of Beaver Falls, Pa.

PAGE TYPE OF BASCULE BRIDGE: CHICAGO, ILL.

The Page type of bascule bridge has been adopted for some highway bridges, but the first bascule bridge of this type for railway purposes has recently been completed at Chicago. This is a double-track single-leaf structure, with a span of 150 ft. from center of trunnion to center of end bearing. It crosses the south fork of the Chicago River, and is for the joint use of the Chicago & Alton Ry., Illinois Central Ry., and Atchison, Topeka & Santa Fe Ry. A plate-girder span of 64 ft. extends from the trunnion pier to the abutment, but there is no tail-pit, as the heel of the truss is 10 ft. above the water line even with the bridge open. The rail level is 24 ft. above water line. This bridge was designed by Mr. W. M. Hughes, M. Am. Soc. C. E., of Chicago, consulting bridge engineer. The superstructure was built by the American Bridge Co., and the erection was done by Kelly & Atkinson, of Chicago. The contractors for the substructure were Thomas Phee & Co., also of Chicago. Mr. Ekstrom was Resident Engineer for the railway company.

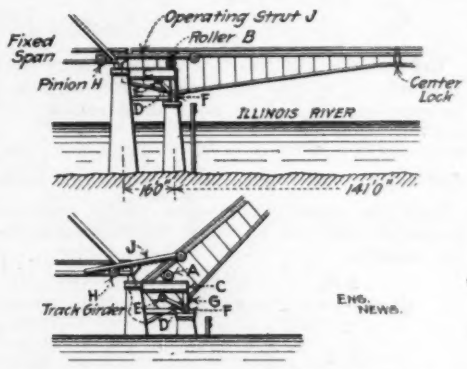


Fig. 3. Operating Mechanism of Rail Type of Bascule Bridge.

The general principle of the Page type has been described in our issues of April 25, 1901, and May 10, 1906. The end posts at the trunnion end are inclined in the opposite direction from the end posts of an ordinary truss, and close to them are heavy plate girders, or track girders, carrying racks on the curved side facing the channel. Above the approach span, and hinged to a steel bent or tower on the abutment, are horizontal counterweight girders, having the outer ends carried by pinions and rollers resting on the track girders. The motors and operating machinery are mounted on a frame between the counterweight girders. When the pinions are driven, they pull back the heel of the truss, and the outer end of the counterweight frame swings down as the heel descends. Fig. 4 is a view of the bridge open, with the heel girders dropped to the abutment, and the counterweight girders inclined from the top of the bent which carries the operating tower. Fig. 5 is a view of the bridge closed. It will be noted that the columns on the abutment are braced to the trunnion pedestal at top and bottom, the construction forming a triangular frame or bent on each side. The height from trunnion pin to counterweight pin is 48 ft. 6 ins. The bridge crosses the river on a skew, giving a clear channel of 100 ft.

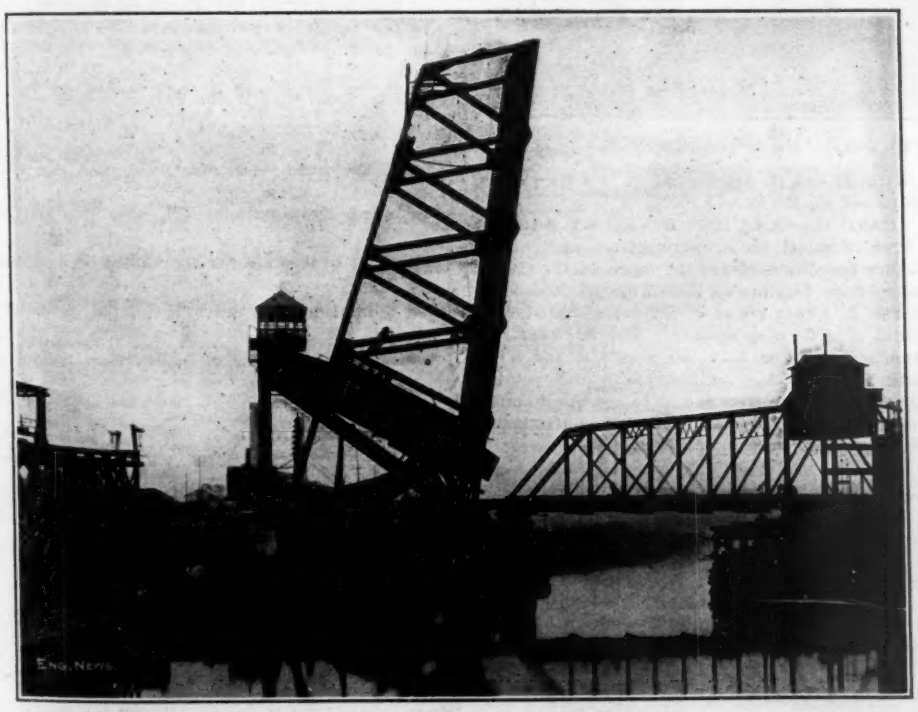


FIG. 4. BASCULE BRIDGE (PAGE TYPE) IN COURSE OF ERECTION AT CHICAGO, ILL.
(The old bridge shown was used during construction, trains passing through the heel of the new bridge.)

The bridge is of very heavy construction, and is designed for a load of two 180-ton consolidation engines on each track. Its panels are 30 ft. in length, and the trusses are 34 ft. 3½ ins. c. to c. The machinery is driven by two 125-HP. electric motors. The bridge can be operated by a force of 65 HP., but owing to the heavy traffic ample power was supplied for quick operation and to provide for emergencies. During operation under a wind velocity of 30 miles per hour, the ammeter indicated little increase in the power required, and it is considered by the engineer, Mr. Hughes, that 15 lbs. per sq. ft. for wind pressure (corresponding to a velocity of 50 to 55 miles an hour) is an ample allowance in the design of bascule bridges. In his discussion of Mr. C. C. Schneider's recent paper, on "Moveable Bridges,"* Mr. Hughes made the following statement in regard to the motor equipment of bridges of this class:

> When electric motor power is used for the operation of bridges, the writer is of the opinion that it is desirable to use two motors, each of sufficient capacity to handle the bridge, possibly at a somewhat reduced speed, with one motor only in service. This adds slightly to the first cost of the bridge, but practically nothing to the cost of operation, and reduces the chances of the bridge being thrown out of service, due possibly to the armatures burning out, or some other accident to the motor. When two motors are used, each with sufficient capacity to operate the bridge, it would be hardly reasonable to design the machinery with the usual factor of safety for the full capacity of both motors; although, no doubt, some additional allowances should be made, say 50%, which would provide amply for depreciation due to wear.

The main pinions which ride on the operating rack, and the rollers which transmit the load of the hinged counterweight frame to the track girders, are keyed upon a hollow cast steel shaft, 24 ins. diameter, with a 17-in. hole. The size of this shaft was fixed by the area for the bearing of the rollers, which have phosphor-bronze bushings, the allowed pressure being 1,200 lbs. per sq. in. The rollers make less than three revolutions in opening or closing the bridge. The specifications for moveable bridges prepared by Mr. C. C. Schneider, and given in the paper above mentioned, allow a weight of only 600 lbs. per sq. in. for moderate speeds and 2,000 lbs. for trunnion bearings. In his discussion of this paper, Mr. Hughes expressed the opinion that these figures were respectively too low and too high. In the Chicago & Alton Ry. bridge he used 1,200 lbs. for the trunnion; this was more particularly for the purpose of ensuring proper lubrication, which is made difficult by the fact that the trunnion makes less than one-fourth of a revolution in the opening or closing of the bridge.

There are 80 trains a day over the bridge, and this made the erection work a somewhat difficult problem. The structure replaces an old swing bridge having one channel arm and a short counterweight arm. The trunnion pier was built behind the old pier, and the bridge erected in the open position. This necessitated making the fixed tower or bent higher than would otherwise have been necessary, so that with the counterweight girders lowered, as in Fig. 4, the trains could pass under the machinery floor which spans between these girders. Each rack girder (or heel girder) weighed 70 tons, and was set in place in about 1½ hours (between trains) by means of four sets of blocks attached to the falsework. When the bascule bridge was completed, the old swing bridge was torn out on a Sunday, trains being temporarily diverted. It had been expected that this could be done in ten hours, but owing to many of the pins being hard to drive out it took 60 men nearly 24 hours.

*"Proceedings of the American Society of Civil Engineers," February, 1907.

WIND REACTIONS IN MILL-BUILDING FRAMES.

By C. H. WOOD.*

A cross-bent of a steel shed or mill-building is generally composed of two columns, a roof truss, and knee-braces from the truss to the columns. In designing the individual members of such a bent, the wind-stresses are an important consideration. The calculation of these stresses depends primarily on the amount of horizontal reaction at the foot of each column. When the shed has a side covering, supported by horizontal girts attached to the columns, the windward and leeward columns are differently loaded and in consequence they do not take equal proportions of the horizontal reaction.

There are two general cases, namely, (1) When fastenings and foundations are insufficient to produce appreciable moment at the foot of the columns, in which case the columns are assumed to be hinged at the base. (2) When the columns are rigidly attached to substantial foundations, so that they may be considered as fixed in direction at the base.

Two methods are available for computing wind stresses:

1. The approximate method, used by Prof. M. S. Ketchum in his "Steel Mill Buildings." For columns hinged at the base, this method is based on the assumption of equal horizontal reactions at windward and leeward foundations. For columns fixed at the base, the horizontal reactions

FIG. 5. BASCULE BRIDGE (PAGE TYPE) OVER THE CHICAGO RIVER.

at the points of contraflexure, taken midway between base of column and foot of knee, are assumed to be equal. In both cases the wind is taken as concentrated at the joints.

2. The method given by Prof. J. Sondericker in his "Graphic Statics"; this is based on the assumption of equal deflections at the joints.

The first method, while simple, is irrational. The second method appears to be sufficiently rational to meet all needs in mill-building calculation. But the formulas given by Prof. Sondericker are rather complex. What follows here is an attempt to put these formulas in such simple shape that they can be more easily applied in practical design.

CASE I.—COLUMNS HINGED AT BASE.

Prof. Sondericker's assumptions, nomenclature and formulas are as follows: The dimensions are denoted as in the diagram Fig. 1 herewith; W is the wind load on the side of the windward column, and ΣH is the total horizontal wind load. It is assumed that the truss is comparatively rigid, and that therefore the distances $e\,e'$, $d\,d'$, and $b\,b'$ remain unchanged, while the columns bend as shown by the dotted lines in Fig. 1, being assumed free to turn at the joints e, d, b, e', d' and b'. Then the two wind reactions are:

$$H_1 = \frac{\Sigma H}{2} + \frac{a^2+3ac-c^2}{16ac} W \quad \ldots\ldots(1)\dagger$$

$$H_2 = \frac{\Sigma H}{2} - \frac{a^2+3ac-c^2}{16ac} W \quad \ldots\ldots(2)\dagger$$

Now let $w = \frac{W}{c}$ = wind load per lineal foot of column. Then equations (1) and (2) may be written in this form:

$$H_1 = \frac{\Sigma H}{2} + \frac{a^2+3ac-c^2}{16a^2} w\,a \quad \ldots\ldots(3)$$

$$H_2 = \frac{\Sigma H}{2} - \frac{a^2+3ac-c^2}{16a^2} w\,a \quad \ldots\ldots(4)$$

Let $a = k\,c$, and give to k values ranging from 1 to 0.5, by tenths. Then the coefficient of $w\,a$ in equations (3) and (4) takes these values:

$k = \frac{a}{c}$ =	.5	.6	.7	.8	.9	1.0
Coefficient	.1875	.2010	.2030	.1990	.1935	.1875

Thus the coefficient remains fairly constant, so that we may use, as closely approximate working formulas:

$$H_1 = \frac{\Sigma H}{2} + .2\,w\,a \quad \ldots\ldots(5)$$

$$H_2 = \frac{\Sigma H}{2} - .2\,w\,a \quad \ldots\ldots(6)$$

With H_1 and H_2 determined, it is a simple matter to get S_1, R_1, S_2 and R_2.

CASE II.—COLUMNS FIXED AT BASE.

Prof. Sondericker's assumptions and nomenclature for this case are the same as for Case I., the columns bending as shown by the dotted lines in Fig. 2, points e and e' deflecting equally, and d and d' deflecting equally. The additional assumption is made that the points d and d' remain in the same verticals with the points e and e'. The quantities p_1 and p_2 are the distances from the bases to the points of contraflexure. The formulas‡ are:

$$R_1 + R_2 = \frac{3a^2}{2(c-a)(c+2a)} \Sigma H + \frac{3c^3+3c^2a-15ca^2+a^3}{8c(c-a)(c+2a)} W = m\,\Sigma H + n\,W \quad \ldots\ldots(7)$$

$$R_1 - R_2 = \frac{6c^3-12c^2a+6ca^2-a^3}{4c(c-a)(4c-a)} W = s\,W \quad \ldots\ldots(8)$$

$$S_2 = \frac{2c^2+2ca-a^2}{3a^2} R_2 = t\,R_2 \quad \ldots\ldots(9)$$

$$S_1 = \Sigma H - W + (R_1 + R_2) - S_2 \quad \ldots\ldots(10)$$

Now let $a = k\,c$, give k values from .9 to .5, and calculate the values of the coefficients m, n, s and t in equations (7), (8) and (9). The results are as follows:

k =	.5	.6	.7	.8
m	+ .375	+ .613	+1.021	+1.846
n	+ .100	− .054	− .331	− .887
s	+ .196	+ .137	+ .050	− .106
t	+3.667	+2.630	+1.980	+1.542

Now $H_2 = S_2 - R_2$.

As before, let $w = \frac{W}{c}$ = wind per lineal foot of column.

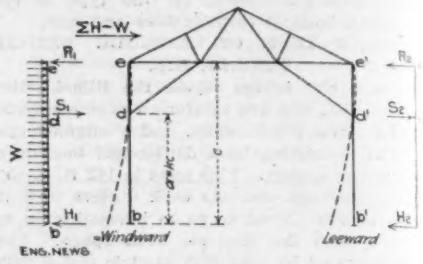


Fig. 1. The Mill-Building Bent, Columns Hinged at Base.

Then from (7), (8) and (9) we obtain

$$H_1 = \frac{\Sigma H}{2} + \frac{(t-1)(s-n)c}{2a} w\,a \quad \ldots\ldots(11)$$

$$H_2 = \frac{\Sigma H}{2} - \frac{(t-1)(s-n)c}{2a} w\,a \quad \ldots\ldots(12)$$

The values of the coefficient of $w\,a$ in equations (11) and (12) for different values of k, are as follows:

$k = \frac{a}{c}$ =	.5	.6	.7	.8	.9
Coefficient	.232	.259	.267	.264	.258

The coefficient thus remains fairly constant, and approximate working formulas are

$$H_1 = \frac{\Sigma H}{2} + 0.26\,w\,a \quad \ldots\ldots(13)$$

$$H_2 = \frac{\Sigma H}{2} - 0.26\,w\,a \quad \ldots\ldots(14)$$

Having determined H_1 and H_2, it remains only to find p_1 and p_2, the distances from the bases to the points of contraflexure, the points where the bending moments are zero.

It is clear that if the ratios $\frac{a}{c}$ and $\frac{\Sigma H}{W}$ are fixed, the ratio $\frac{p_1}{a}$ is also fixed, and can be determined by equations (7), (8), (9) and (10). This has been done for six values of $\frac{\Sigma H}{W}$, varying from 1 to 2 by intervals of 0.2, in combination with five values of $\frac{a}{c}$, varying from 0.5 to

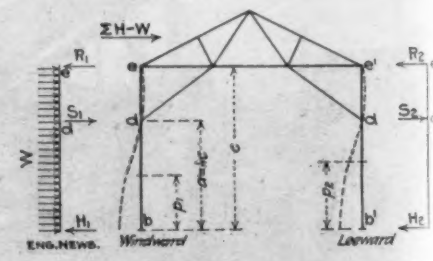


Fig. 2. The Mill-Building Bent, Columns Fixed at Base.

0.9 by intervals of 0.1, and the results used to get the plotted curves shown on the diagram Fig. 3. For $\frac{p_2}{a}$ we have the well-known portal formula

$$\frac{p_2}{a} = \frac{1}{2}\,\frac{a+2c}{2a+c},$$

*43 West 39th St., New York City.

†For derivation see Sondericker's "Graphic Statics," pp. 84-86.

‡For their derivation see Sondericker's "Graphic Statics," p. 88.

which is independent of the ratio $\frac{\Sigma H}{W}$.

A curve giving the values of $\frac{p_2}{a}$ corresponding to different values of $\frac{a}{c}$ is shown on Fig. 3;

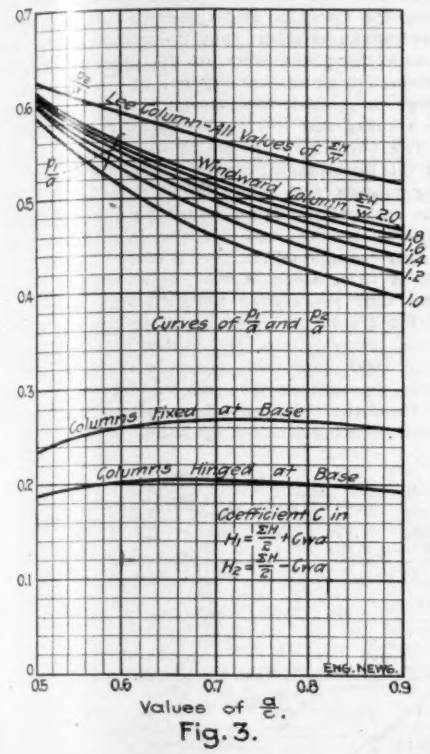


Fig. 3.

also curves giving the exact values of the coefficients of $w\ a$ in equations (3), (4), (11) and (12).

As a practical example, take a bent of the general dimensions shown in the sketch Fig. 4; wind at 20 lbs. per sq. ft., reduced by Hutton's formula for roof slope; bents 15 ft. apart; columns fixed at the base. Then $\Sigma\ H = 9{,}000$ lbs.; $W = 6{,}000$ lbs.; $w = 300$ lbs.; $a = 16$ ft.; $c = 20$ ft.; $a/c = 0.8$; $\Sigma\ H \div W = 1.5$. From the curves in the diagram, Fig. 3, we have

$$H_1 = \frac{\Sigma H}{2} + .264\ w\ a = \frac{9{,}000}{2} +$$

$$.264 \times 300 \times 16 = 5{,}767 \text{ lbs.}$$

$$H_2 = \frac{\Sigma H}{2} - .264\ w\ a = \frac{9{,}000}{2} -$$

$$.264 \times 300 \times 16 = 3{,}233 \text{ lbs.}$$

$p_1 = 0.472\ a = 0.472 \times 16 = 7.55$ ft.
$p_2 = 0.538\ a = 0.538 \times 16 = 8.61$ ft.

With these four values found, it is easy to proceed to find the stresses in the truss.

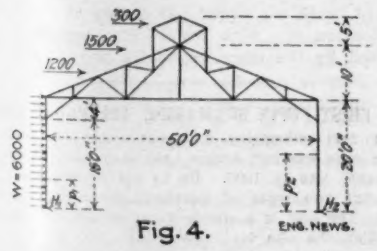


Fig. 4.

For the shear at the point of contraflexure in the windward column we have

$$5{,}767 - 7.55 \times 300 = 3{,}502 \text{ lbs.}$$

Maximum bending moment in windward column is at the base and equals

$$3{,}502 \times 7.55 + \frac{300 \times 7.55}{2} = 34{,}990 \text{ lb.-ft.}$$

Maximum bending moment in leeward column is at the base and equals

$$3{,}233 \times 8.61 = 27{,}836 \text{ lb.-ft.}$$

For columns hinged at the base we have

$$H_1 = \frac{\Sigma H}{2} + .199\ w\ a = \frac{9{,}000}{2} +$$

$$.199 \times 300 \times 16 = 5{,}455 \text{ lbs.}$$

$$H_2 = \frac{\Sigma H}{2} - .199\ w\ a = \frac{9{,}000}{2} -$$

$$.199 \times 300 \times 16 = 3{,}545 \text{ lbs.}$$

Maximum bending moment in windward column equals

$$5{,}455 \times 16 - \frac{300 \times 16 \times 16}{2} = 48{,}880 \text{ lb.-ft.}$$

Maximum bending moment in leeward column equals $3{,}545 \times 16 = 56{,}720$ lb.-ft.

TESTS OF COLD-TWISTED STEEL RODS FOR CONCRETE REINFORCEMENT*.

By JESSE J. SHUMAN.†

After several years' experience with the manufacture of cold-twisted steel bars for concrete reinforcement the writer feels that there is not enough definite information on the subject. These notes are published in the hope that they may help engineers to write "safe and sane" specifications to govern the quality of an important material of construction. They may also be of value to those who are called upon to decide on the relative merits of the numerous styles of concrete bars.

NUMBER OF TURNS.—The moment the twisting machine has created a permanent set in the fiber, the steel has begun to increase in strength, in the same manner as higher yield-point and ultimate strength are set up in a bar when it is slightly stretched in a testing machine. As the twisting proceeds the yield-point ascends more rapidly than the ultimate strength. There is a point, however, at which the maximum strength of the bar is reached, and beyond which it is reduced somewhat before the bar twists apart.

The interesting behavior of half-inch squares of three widely different grades is shown in Table I. It would clearly be a mistake to specify a number of turns approaching the maximum strength of the steel, for the internal strains in such a bar are already nearly enough to destroy it; yet it is not uncommon for engineers to do this very thing. In the writer's opinion the number of turns should be about half the number at which the steel is at its maximum strength, and in the ordinary soft Bessemer product this means one complete twist in 8 to 10 times the size of the bar; in other words the pitch of the twist should be 8 to 10 for Bessemer steel of about 60,000 lbs. tensile strength. Basic open-hearth squares of similar grade should have a pitch of 5 to 7 in order to have their best properties developed. If carbons higher than ordinary structural grades are insisted upon, a proportionate concession must be made in the number of twists.

QUALITY.—Excellent results have been obtained with both Bessemer and open-hearth steels of a wide range of carbons. It seems reasonable, however, that the grades that have been found to be best adapted to structural work would also be most reliable for reinforced concrete. Bessemer steel containing carbons up to 0.30 or 0.40% can be twisted successfully, and are very high in tensile properties, but they have the same brittleness that constitutes the strongest argument against the various hot-rolled and hot-twisted concrete bars. The latter must be high in carbon in order to yield an elastic limit that even approaches that of the soft steel cold-twisted square rods. Surely the lowest yield point in Table II., in which are shown results on soft Bessemer bars, is high enough to suit the most exacting requirements.

On low-phosphorus steel the effect of twisting is not as marked as on Bessemer steel, the behavior in this respect being quite similar to that of the same steel when cold-rolled or cold-drawn. The lower results are readily raised, however, by carrying the twisting process further. Table III shows what can be expected of basic open-hearth bars of 55,000 to 65,000 lbs. tensile strength twisted an appropriate number of turns.

Manifestly it would be a poor plan to use open-hearth steel softer than the tests shown in this table, but it would be both safe and advantageous to use steel up to about 0.35% carbon, with phosphorus under 0.04%.

ELASTIC LIMIT.—Inasmuch as the function of a reinforcing bar is performed inside the elastic limit, the elastic limit is the feature of highest importance from the engineers standpoint. It is here that the cold-twisted square excels all hot-finished sections and must always continue to do so, for its elastic limit of 60, 70 and even 80 thousand pounds permits the use of less steel for the same service than can be guaranteed by its competitors.

In the testing laboratory it is necessary to take unusual pains to observe the yield-point, commonly called elastic limit, for the reason that the beam of the machine does not alway drop when the point is reached at which permanent deformation begins. The machine should be run not faster than ⅝-in. per minute, and in the absence of an autographic device a pair of dividers should be held on the specimen until the yield-point is observed.

PROPOSED SPECIFICATIONS FOR COLD-TWISTED RODS.—Specifications for cold-twisted bars should be consistent with the behavior of steel of known quality, and should recognize the empirical laws peculiar to the material. Thus, to summarize and add to points made in this paper, the following suggestions are offered as a broad foundation for specifications.

1. Process. Specify whether open-hearth or Bessemer steel is to be used, or either. Open-hearth steel should contain less than 0.04% phosphorus for basic and 0.06% for acid steel.
2. Carbon. This should usually be left to the discretion of the manufacturer, who insists that when carbon limits are named the tensile requirements should be left open.
3. Elastic Limit. For squares ½-in. and smaller, this should be at least 65,000 lbs.; for squares ⅝-in. to 1 in. at least 60,000 lbs., and for squares 1⅛-in. and larger at least 55,000 lbs. Manufacturers can generally guarantee minima values somewhat higher than these, but the above would be a reasonable specification.
4. Ultimate Strength. To be recorded.
5. Elongation. At least 5% in 8 ins. or 12% in 2 ins.
6. Reduction of Area. To be recorded.
7. Bend. Bars to bend cold around a pin twice their size without distress.

TABLE I.—EXPERIMENTS WITH ½-IN. TWISTED SQUARES, SHOWING THE EFFECT OF INCREASING NUMBER OF TWISTS.

Grade.	No. of Turns per Foot.	Yield-point. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.	Ultimate Strength. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.
Soft Bess.	3	41,600	65,600	57.7	60,400	83,200	37.7
"	4¾	39,200	72,400	84.7	60,000	89,600	49.3
"	5	41,600	84,800	103.8	60,800	92,000	51.3
"	5¾	40,800	84,000	105.9	60,400	90,000	49.0
"	5⅞	40,000	80,800	102.0	60,800	88,800	46.0
Bess. .25 Carb.	3	48,800	83,600	71.3	74,000	96,000	29.7
"	4½	51,200	83,200	62.5	75,200	99,200	31.9
"	4⅞	52,800	88,800	68.2	75,200	104,000	38.3
"	5	51,200	84,200	64.4	75,600	102,000	34.9
"	5½	53,200	84,200	58.3	75,200	100,800	34.0
Soft O.H.	3	31,200	46,000	47.4	46,400	64,000	37.9
"	5	31,200	60,800	94.9	47,200	68,000	44.1
"	7	31,200	68,800	120.5	46,000	76,000	65.2
"	9	31,200	67,200	115.4	47,200	71,200	50.8

TABLE II.—TESTS ON PLAIN AND COLD-TWISTED STEEL BARS, SOFT BESSEMER STEEL.

Number of Turns, Ordinary.

Size. Inches.	No. of Turns per Foot.	Yield-point. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.	Ultimate Strength. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.
¼×¼	4	36,800	80,000	117.4	65,600	92,800	41.5
"	4	38,400	78,400	104.2	68,800	91,200	32.5
½×½	3	41,600	65,600	57.7	60,400	83,200	37.7
"	3	38,600	66,000	71.0	63,100	91,200	44.5
¾×¾	1½	40,340	74,680	85.1	60,450	80,860	33.8
"	1½	39,120	72,720	85.9	60,080	81,000	34.9
1×1	1	36,000	66,000	83.3	61,000	73,900	24.4
"	1	37,400	67,500	80.5	61,000	74,000	21.3
1¼×1¼	¾	39,530	61,100	54.5	61,420	78,950	28.5
"	¾	38,251	62,510	63.4	61,300	79,270	29.3

TABLE III.—TESTS ON PLAIN AND COLD-TWISTED STEEL BARS, OPEN-HEARTH OF 55-65,000 LBS. TENSILE STRENGTH.

Number of Turns, Special.

Size. Inches.	No. of Turns per Foot.	Yield-point. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.	Ultimate Strength. —Lbs. per sq. in.— Plain.	Twisted.	Increase. Per cent.
½×½	5	38,000	58,000	52.6	61,200	92,000	50.3
"	5	37,600	60,000	59.6	60,400	91,200	51.0
¾×¾	2½	31,170	52,800	69.4	57,020	69,670	22.2
"	2½	34,370	55,770	62.3	57,050	69,300	21.5
1×1	1¾	33,120	57,920	74.9	57,430	67,480	17.5
"	1¾	33,360	54,350	62.9	59,000	72,300	22.4
1¼×1¼	1½	33,740	62,230	84.4	55,550	68,890	24.0
"	1½	32,050	57,140	73.4	55,810	73,340	31.4

*Paper read before American Society for Testing Materials, Atlantic City, June 22, 1907.

†Chief Inspector, Testing Department, Jones & Laughlin Steel Co., Pittsburg, Pa.

8. Number of Turns. For Bessemer steel, one complete turn in 8 to 10 times the size of the square; for open-hearth steel, in 5 to 7 times the size.

9. Number of Test Pieces. One tension-test specimen and one for bending test for each melt used in each size.

10. Inspection. All tests governing the acceptance of material to be made at manufacturer's works. Inspector to have access to the bars prior to shipment, but the manufacturer is not relieved thereby from responsibility for unsatisfactory material. In this connection it may be stated that each bar is thoroughly cleaned by the twisting process, and that each piece is in a large measure tested at the same time, as no imperfect bar will stand the cold-twisting process.

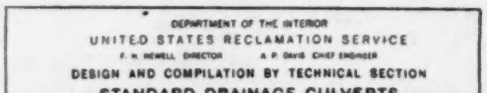
AN IMPROVED SYSTEM OF LETTERING MAPS AND DRAWINGS.

By HENRI V. LEMENAGER.*

The lettering on maps and drawings will usually be found to constitute a considerable proportion of the finished product when the time and expense needed for its execution is taken into consideration. The results secured in this feature of the work are seldom uniform or satisfactory, notwithstanding the amount of time and effort usually expended thereon, for the reason that engineers and designers are not necessarily good draftsmen and good draftsmen are not always neat and rapid letterers. The efficiency of maps and drawings as well as their general appearance depends so largely upon having the lettering, titles, etc., neat, legible, appropriate in character and uniform in style that a brief description of a system of type-printed lettering, which has been in successful use in the drafting section of the Reclamation Service for the past four years, may be of some interest.

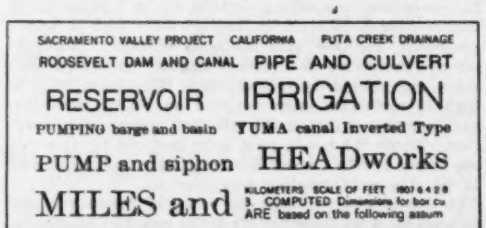
The methods to be described are intended to apply only in cases where the principal object in view is the reproduction of an edition of say 25 copies or more, and where the appearance of the original is of less importance than its fitness for a cheap and efficient method of reproduction. In such cases the preparation of the map or drawing proceeds in the usual way, except for the lettering, which as far as possible is set up in type of suitable size and style and printed upon gummed paper. These printed impressions, after the ink is dry, are cut up as required by the draftsman and stuck in place on the drawing or tracing, as the case may be, only such lettering being done by hand as may be put in to the best advantage in that way. Care and common sense of course are necessary in placing the type-printed impressions upon the original in such a manner that they will adhere properly, in cutting and placing them so that the strips of paper do not cover or interfere with other essential features, etc. But as the draftsman gets accustomed to the work, numerous little schemes and devices will suggest themselves to overcome apparent objections and difficulties and to facilitate the handling of the type-printed impressions and their adjustment on the sheet.

In offices where large numbers of maps, drawings and illustrations are prepared or handled for reproduction and where the necessity often arises for getting them out in very limited time, this system of type lettering will be found to effect a wonderful saving of time as well as expense. Lettering that would take a day or more to do by hand can be set up and impressions furnished in an hour or less, and the draftsman is thus relieved of a corresponding amount of work. It remains then only for him to place the type impressions properly upon the work in hand, or, if desired, indicate by writing in pencil where they can be placed by others. In the placing of titles upon maps and drawings—that once laborious and elaborate process—the type lettering will be found invaluable where neatness and economy are considerations.



Standard Form of Title Used on U. S. Reclamation Service Drawings (Reduced Over One-Half from Original).

The essential equipment for type lettering consists of a small hand-printing press with the necessary accessories, and a selection of suitable type of various sizes and styles. The amount and variety of type can, of course, be governed by the requirements of the work. The paper used for printing the impressions is a thin white paper gummed on one side. The outfit can be handled successfully after a little experience and practice by an intelligent apprentice, but the final results will, of course, depend upon the amount of care and intelligence displayed at every point along the line.

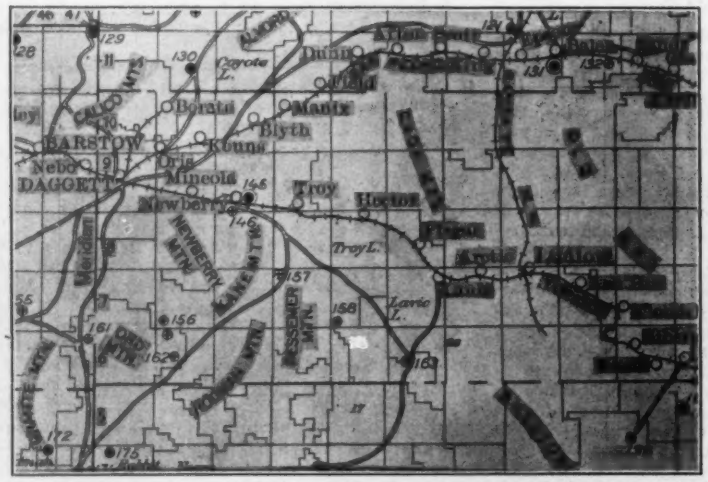

SACRAMENTO VALLEY PROJECT CALIFORNIA PUTA CREEK DRAINAGE
ROOSEVELT DAM AND CANAL PIPE AND CULVERT
RESERVOIR IRRIGATION
PUMPING barge and basin YUMA canal Inverted Type
PUMP and siphon HEADworks
MILES and
THE modulus of elastic
TABLES CONTINUED ON DRAWING NO. 23
DIMENSIONS CARLSB
ROOSEVELT DAM SITE HONDO PROJECT
DESIGN AND COMPILA TION BY TECHN
STANDARD DRAIN GENERAL

Some Useful Forms of Type in Use on Maps and Drawings (Reduced One-Half from Original).

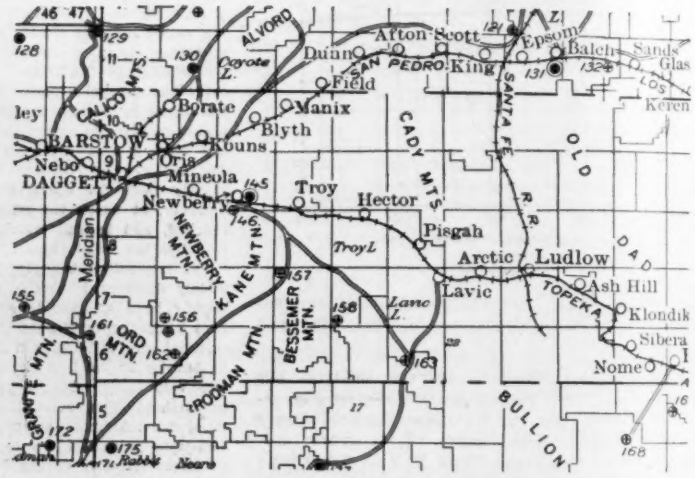
An original map or drawing, when prepared as outlined above, with the type-printed paper impressions stuck in place, will, of course, present a very patchy appearance and will not be available for direct or solar printing. It will, however, make excellent copy for photolithographing, zinc etching and some of the other modern reproductive processes, any one of which, where a large or a moderately large edition is required, is a cheap and efficient means of reproduction.

The outfit now in use in the drafting section of the Reclamation Service consists of two printing presses with about 30 varieties of type and the necessary equipment of furniture, printers' accessories, etc., and has cost in all about $300. As an example of the saving effected in the matter of titles alone, it may be stated that in the past four years over 1,000 drawings have been issued from this office in connection with published specifications, and during the same period over 2,000 plane-table sheets have been received from the various field offices. On the majority of these the titles have been printed in type instead of being lettered by hand, and a saving of time and expense effected that can readily be appreciated.

In the compilation of maps intended for publication, including those to be printed in colors, the use of type has been extended to include practically all the lettering. In such cases, especially where several hundred names would otherwise have had to be carefully lettered by hand, a large saving in time and cost in the preparation of the originals has been effected. At the same time, on account of the superior neatness and efficiency of the type lettering, the maps have been reproduced direct, instead of being re-drawn or engraved, with an additional saving in the cost of publication and with results comparable to those secured by the more expensive processes.



PART OF A RECLAMATION SERVICE MAP WITH LETTERING ATTACHED ON ADHESIVE STRIPS.



THE SAME MAP AFTER PHOTO-REPRODUCTION AS A LINE ENGRAVING.

(These two engravings are reduced to two-thirds the size of the originals.)

*Chief Draftsman, U. S. Reclamation Service, Washington, D. C.

THE FIRST PUPIN SUBMARINE TELEPHONE CABLE.*

The first submarine telephone cable equipped with Pupin coils was laid across Lake Constance, in Southern Germany, late in 1906. Up to the present there have been but two types of telephone cables for submarine lines. The first is a simple gutta percha covered affair, in which the aim is to keep down resistance and capacity. The electrical resistance is decreased by increasing the cross section of the copper conductor and the capacity is lowered by increasing the thickness of gutta percha covering.

In the second type self-induction is introduced into the circuit to overcome the capacity effects, by giving the cable a covering of iron wire. The largest number of conductors laid in such cables has been limited on the

*From an article in the London "Electrician," May 24, 1907.

Continent to four, making only two complete circuits. If the cable is constructed so that each conductor lies symmetrical in respect to both conductors of the other circuit, there is no cross talk between the two circuits. This method is beneficial only within certain commercial limits, as the capacity is increased by the addition of the iron covering, unless the thickness of insulation be increased so much that the expense becomes prohibitive.

By means of the system of Prof. M. I. Pupin, which has been described in these columns* the self induction can be raised, by predetermined amounts, and a calculated condition of the circuit obtained. In this system special coils are inserted at calculated points, and while for ordinary underground work little difficulty has been encountered and a large amount of work has been done with this system in such situations, yet on submarine work the insertion of the Pupin coils gives several mechanical troubles. In order to study the difficulties best, Messrs. Siemens and Halske decided to locate the first cable in Lake Constance, between Romanshorn and Friederichshafen, a distance of 9 1-3 mi. The number of circuits was fixed at seven.

The contour of the course gradually falls to a deep channel, of a maximum depth of 828 ft., which is nearly reached by the cable. The cable had to withstand then a pressure of some 25 atmospheres. It was not considered advisable to have the conductors under pressure, and the protective sheath had to have sufficient collapsing resistance. Obviously lead cables would not serve, and, after experimenting, a method was evolved whereby the core was covered with spirals of steel wire having a diameter of two millimeters.

It was demanded that the whole cable be fitted every 1,800 ft. with a device for preventing passage of water which might be forced in through a fault. This was accomplished by rubber joints placed simultaneously with the connection of the Pupin coils. These coils are circular and are connected in circuit with one conductor of each double wire circuit every 1,100 yds. They were inserted in the already armored cable by hand while the core was stretched by a pull of about two tons. The coils are circular and through their center passes one of the conductors with which they are not connected.

Although the cable was only 9 1-3 miles long the laying had to be done by deep sea apparatus. The weight of the cables was such that in paying out at the deep places a pull of about two tons was developed. In order to handle the cable with its enlarged coil sections a special brake drum was designed, eight feet in diameter, substantially like those on ordinary cable ships. However special guides were necessary to prevent the cable springing off the roller in front of the wheel. Before the real laying, a preliminary test was made at different depths with a short length of cable in which were several coils. One end was anchored and the rest paid out at a high speed. The test cable was laid and recovered several times and was dragged about the bottom. The results showed great reliability of the cable construction, and while the jute serving was destroyed, the coils were undamaged.

The laying of this first Pupin submarine cable seems to have solved several mechanical problems and other cables may be expected as a result of the success of this one.

The Pupin inductance coils have been employed to a limited extent for aerial cable construction, but the need for measures to overcome capacity has not been so great as in submarine work. However, when this system is applied to aerial cables, the results are as certain and as beneficial as when adapted for use under water.

MECHANICAL CANAL LOCKS IN CANADA.†

By WALTER J. FRANCIS,‡ M. Can. Soc. C. E.

INTRODUCTORY.

Built for the Canadian Government, by Canadian contractors, under the direction of Canadian engineers, the hydraulic locks on the Trent Canal may properly bear the label, "Made in Canada." In view of the fact that the German Government has recently completed a high canal lift at Heinrichenburg, and that the State of New York has made a careful study of the problem of mechanical lifts in connection with the reconstruction of the Erie Canal, a detailed description of the Canadian hydraulic locks may be considered appropriate at the present time.

The larger of the two Canadian locks is situated on the Trent Canal, within the limits of the corporation of the city of Peterborough, and has been in operation for the past two seasons. The other lock, near the village of Kirkfield, is practically completed in a stretch of canal joining Balsam Lake and Lake Simcoe.§

The hydraulic lock is theoretically an automatic machine, and is designed to take the place of ordinary locks where a great difference of level is found in a short distance. Besides the Peterborough lock, there are three other locks of this type in operation, one being in England, another in Belgium, and the third in France. The English lock has been in continuous use for over 30 years, while those in France and Belgium have been completed about 12 years. They all have a lift of nearly 50 ft. The depth of water in the French and Belgian locks is 7 ft. 10 ins. and the lock chambers are 140 ft. long, and 19 ft. wide. Several others having similar dimensions are now being built by the Belgian Government.

The chief dimensions of the Peterborough Lock are 65 ft. lift, chambers 140 ft. long with 33 ft. clear width, and 8 ft. normal depth of water. The Kirkfield lock has the same general dimensions, with a lift of 50 ft. It will thus be noticed that in the Peterborough lock the water load is double that of the larger European ones, while the height of the lift is increased over 30%.

In principle the hydraulic lock may be likened to two immense hydraulic elevators of the simple plunger type, having their presses connected together so that the descent of the one causes the rise of the other. In place of the ordinary elevator platform we have a large watertight box or tank closed at either end by a gate. The lockage is performed by towing the vessel into this box of water and then closing the gate on the end of the box as well as that of the canal, thus leaving the box independent of the reach and free to move vertically. The box with the water and the floating vessel is then raised or lowered to the other reach. The chamber or box about to descend is loaded with a few inches more water than the other chamber, thus giving it the necessary additional load or "surcharge" to enable it to cause the ascent of the other when water communication is established between the two presses. The construction of the Canadian locks varies materially from those of Europe, and as far as outward appearance goes there is little similarity. The departures are largely due to the climatic conditions and to the different practices adopted by American and European engineers in steel construction.

FIG. 1. THE HYDRAULIC LIFT LOCK ON THE TRENT CANAL AT PETERBOROUGH, CANADA; SIDE VIEW.

Peterborough Hydraulic Lock.

For purposes of detailed description the Peterborough lock will be taken first, and the difference in the Kirkfield structure will be noted later in the paper.

SITE.

A gradual slope was selected for the site of the Peterborough lock and the excavation was completed in 1899. The location was chosen so that the average depth of excavation was about 40 ft., and the material thus obtained was used in building embankments to carry the level of the upper reach to the back of the structure. The elevation at which rock was found was exceedingly fortunate, being practically at the bottom of the pits. When the rock was cleaned off less than 2 ft. of concrete brought the floor to its proper grade.

THE PRESS WELLS.

The wells in which the large presses stand were excavated about 75 ft. below the floor of the pits, the diameter of the rock excavation being 16 ft. 6 ins. The nature of the rock rendered this work comparatively easy. In the bottom of each well there is a foundation of granite, the object of which will be quite apparent since the whole weight of the lock chamber and its burden is concentrated on the bottom of the press and from there distributed over the rock. When a satisfactory course of rock was found the surface was bushhammered to a truly level plane in preparation for the granite. The granite blocks composing the foundation were 29 ins. and upward in thickness, and are arranged in three courses, all well bonded. Each stone was carefully dressed and perfectly true in every particular, and no joint, either horizontal or vertical, was permitted to be more than 5-16 in. in thickness. Every stone was set on a floating bed and beaten to its proper elevation with a heavy setting maul. Experience showed that the mortar best suited for this work was made of three parts of cement to one of good sharp sand, with which mixture properly tempered the stones could be set to a nicety.

The top surface of each granite foundation was brought to a perfectly level plane, no deviation being permitted that could be detected by a 10-ft. steel straight edge and a specially designed 24-in. hand level. The steel straight edge used was planed out of an 8-in. 18-lb. steel I-beam. The hand level has a cast-iron base of uniform I-section 24 ins. long, surmounted by a large bubble similar to those used on a Y-level.

The granite stones, many of which weighed over ten tons, were handled from a gantry frame, using a steel hoisting cable with a pair of three-sheave blocks run by an ordinary steam hoist. The most satisfactory way of taking hold of the stones was found to be by a 1½-in. eye-bolt inserted through a hole in the stone and screwed into a nut countersunk in the under bed. After setting the stone the eye-bolt was unscrewed leaving the nut below.

After the granite work was finished the wells were lined with concrete about 14 ins. thick, bringing the diameter to 14 ft. 2 ins. No great difficulty was experienced from water, but in order to render the concrete lining as tight as possible the water in the well was allowed to follow close up to the finished work, thus balancing the back pressure and saving the new concrete from being scoured before setting by water percolating through the rock. This method proved quite satisfactory, and during the placing of the presses the linings were found to be quite water-tight. The form or mold used in making the concrete lining was a collapsible cylinder about 6 ft. in length, and was moved about 5 ft. vertically at a time.

THE SUBSTRUCTURE.

The substructure of the lock is built entirely of concrete, and contains a little over 26,000 cubic yards. For purposes of description the substructure may be divided into (a) the breast wall and wings which serve as retaining walls for the upper reach; (b) the side walls, being the retaining walls for the earth along the sides of the lock; (c) the towers, the duty of which is to maintain the lock chambers in their vertical motion; (d) the lower gateways which end the lower reach. These walls form a dry pit, or rather two dry pits, into which the metal lock chambers descend.

The breast wall is 40 ft. thick, and about 80 ft. high, the length being 126 ft. at the base. At about 15 ft. above the rock foundation there is formed within it a chamber or room, called the pump room, in which the pressure pumps and turbines are installed. This room is 12 ft. wide, 17 ft. high and 110 ft. long. At about the original natural surface of the ground the breast wall is pierced longitudinally by a roadway, which will form a continuation of the main street running through the city of Peterborough. This roadway is 14 ft. wide and 21 ft. high. In the top of the wall there are formed recesses for the gates which close the ends of the upper reach. Stairways are provided to give convenient access to the various parts of the structure. In order to avoid a bare look in so large a wall, as well as to obtain some architectural effect, pilasters, string courses, and cornices have been formed. All ornamentation of this character

*Engineering News, issue of August 23, 1906.
†From a paper read before the Canadian Society of Civil Engineers.
‡Care Dominion Engineering and Construction Co., Sovereign Bank Building, Montreal, P. Q.
§It was formally opened on July 6.

was made as the work progressed, the mouldings or forms being erected as received from the planing mill.

The towers, three in number, are on the same transverse center line as the walls. In round numbers, the total height of each tower from rock bottom to the top is 100 ft. Each of the side towers has a base 29 ft. 6 ins. by 40 ft. 8 ins., decreasing to 24 ft. 6 ins. by 30 ft. 6 ins. at the top of the side wall. From this point upwards the base has a batter for a height of 45 ft., and above this the shaft is vertical, being 18 ft. × 18 ft. 6 ins. For operating purposes it is necessary to build the inside face of the towers plumb from bottom to top. The center tower has for the same reason to be plumb on the two sides next the lock chamber, while its other two sides conform to the same lines as those of the side towers. Its width throughout is 12 ft. The towers have been treated in the same architectural manner as the breast wall.

The lower gateways extend from rock bottom to the top of the side wall, and are built to accommodate the steel gates which close the ends of the lower reach. In the center wall between the gates is a small room which contains the gate-operating machinery.

As far as possible the substructure has been built in sections to make provision for expansion and contraction, and to obtain as nearly as possible evenly distributed pressure on the foundation of each part. An effort was made to have the sections not exceed 40 ft. in length.

Machine-mixed concrete was used throughout the work. About one-half was made in a continuous mixer and the remainder in a cubical mixer. The machines were located on one side of the work, the concrete being delivered to the walls by a cableway, which deposited it in place in batches of one and a-third cubic yards at a time. This arrangement proved economical and quite satisfactory.

In order to obtain the greatest possible accuracy in the alinement of the concrete walls, so as to insure the proper working of the finished lock, a large engineer's transit was used in truing up the forming. At the outset of the work a well-braced wooden tower of the requisite height, surmounted by a wind screen, in which the instrument was placed, was built over a carefully-determined hub, the foresight on the line having been previously determined and referenced on the opposite hillside. In this manner the plumb walls were built with unusual accuracy for a height of nearly 100 ft.

The earth embankment upon which the canal is carried up to the back of the breast wall was built in layers about 8 ins. in thickness, thoroughly compacted and rolled. During the hot and dry season the earth filling was liberally watered. The material was clay containing small stones. This method produced an embankment having the remarkable record for settlement of only about 1-10 ft. in a period of nearly a year where the depth of made earth was upwards of 40 ft.

The contract for the embankment and substructure was executed by Messrs. Corry & Laverdure, of Ottawa, and completed in 1902.

THE SUPERSTRUCTURE.

The superstructure of the Peterborough lock was built by the Dominion Bridge Company, of Montreal. This work was commenced in the summer of 1901, and the structure was completed early in July, 1904. The cost of the superstructure complete was $244,000.

Each of the lock chambers is 139 ft. × 33 ft., with 9 ft. 10 ins. of plating on the sides. These dimensions, with the exception of the depth of water, were fixed by a Government Commission. It is also necessary that a clear headway of 25 ft. be left above the water level. The depth of water for which the lock is constructed would, in ordinary navigation language, be called 8 ft. on the sills. The load of water which each of the lock chambers contains is 1,700 tons, and this is the maximum load which it is necessary to provide for, since a floating vessel displaces only her own weight of water.

STRUCTURAL STEELWORK.

The trusses which carry the load of the chambers are double cantilevers, having curved top and bottom chords. The depth of the trusses at the center is 32 ft., this depth having been chosen with a view to preventing the teetering of the chambers. The trusses are simple, and it is unnecessary to provide for alternate stresses in any of the members, the load being constant and always in the same direction. All the connections are riveted. The top chord cover plate is 30 ins. wide. The diagonals are universal mill plates. The floor beams and stringers form a very stiff system. The plating of the chambers is ⅝ ins. thick on the floor and 5-16 ins. on the side, the floor plating also doing duty as a system of lateral bracing to look after the wind loads and add to the general stiffness. All the joints of the plating are made with single butt-splice plates, planed bevel on both edges and caulked, and the riveting is similar to boiler work.

The whole load of the chambers is brought directly upon the top of the rams by plate girders 9 ft. deep. There are four of these girders to each chamber, each girder taking practically an equal share of the load.

In order to maintain the chambers in their vertical courses, guides are provided at the towers and the breast wall, the anchorage having been embedded during the construction of the concrete work. Corresponding slides are attached to the chamber. All the guides combine to counteract the rotating tendency due to the unbalanced wind forces, while the teetering tendency is overcome by the central slides which are fastened to the top and bottom chords of the trusses. The central slides are of bronze, and provision has been made for adjustment in every case.

GATES AND THEIR MECHANISM.

The gates and their operating machinery are of a different type from anything that has hitherto been employed for this purpose. There are eight gates in all, one on each end of each chamber, and one on each end of each reach. Each gate is hinged along its lower edge, and is provided with galvanized air chambers of sufficient capacity to render it practically buoyant. As it is never necessary to operate any gate singly, they have been arranged to work in pairs and to engage automatically. Each of the down-stream pairs is operated by a small three-cylinder hydraulic engine placed on the line of the axis of the reach gates in the small room provided for the purpose in the concrete walls between the gateways. A similar engine is employed for the upper gates. Through the chain, motion is imparted to the pinion engaging with the segmental rack anchored to the wall. There is a similar rack on each side of the gateway, the top shaft being carried across the gate. When open, both gates lie flat upon the bottom, leaving the full navigation depth of water above them.

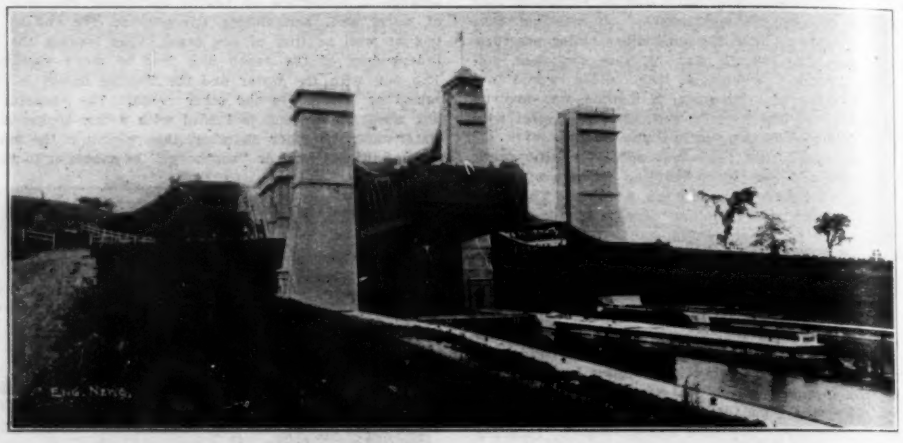
The gates are steel throughout, the framework consisting of a series of vertical I-beam posts, which connect to the top girder, giving a perfectly determinate system of stresses throughout, and bringing definite abutment loads where they can be readily cared for. The plating is all on the outer sides of the gates (that is, the adjacent faces of any pair), is 5-16 in. thick on the upper parts, ⅜ in. thick below, butt-spliced and caulked in the same way as in the lock chamber.

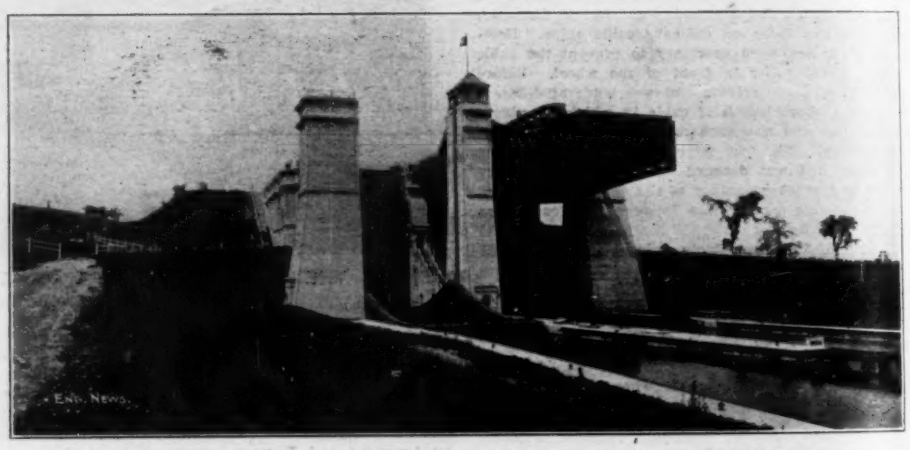
Water-tightness is ensured between the gates and the chambers, or the gates and the reaches, by means of a rubber strip or flap, 2½ ins. × ½ in., fastened along the sides and bottom of the frame against which the gate closes. The pressure of the water keeps this strip tightly pressed against the gate, in this way preventing leakage. The edge against which the rubber bears is machined to a true surface.

There is a space of nearly 2 ins. between either end of the lock chamber and the frame of the reach gate. When it is desired to connect the lock chamber with a reach, this clearance space has to be closed. This is done by having a collapsible rubber tube fastened to the frame of the reach gate and arranged so as to lie flat. When the lock chamber is in position for communication, the rubber tube is inflated with air at about 10 lbs. per sq. in. pressure, which causes it to expand and press against the end of the chamber.

THE MAIN PRESSES AND RAMS.

The main presses form the most interesting as well as the most important part of the whole structure. It is thought that they are the largest hydraulic presses that have ever been made. Each ram is 90 ins. external finished diameter, and has a working stroke of 35 ft. The gage pressure in the presses during operation is very nearly 600 lbs. per sq. in. The inside diameter of the press is 7 ft. 8½ ins., giving a water space of 1¼ ins. all round between the ram and the press. The rams are built of cast-iron, 3¼ ins. thick, made up in sections. Each section is 5 ft. 2 ins. long, and is bolted to the adjacent one by bolts through inside flanges, for which purpose forty 1¼-in. bolts are used. The joints between the sections are made with a gasket of pure copper, rolled true to gage, 1-10 in. thick by ⅜ in. wide. This gasket is brazed in the form of a ring. The ends of the ram sections are rabbetted to fit into one another, and have male and female corrugations. The copper is put in flat, and when the joint is screwed down tightly it becomes corrugated, making the joint absolutely tight.





FIGS. 2 AND 3. VIEWS OF PETERBOROUGH LIFT LOCK FROM LOWER LEVEL.

It is interesting to note the principles employed in the construction of the presses of the European locks. In the two largest ones the rams are 2 meters in diameter. In one the presses are made of cast-iron sections, strengthened by steel hoops shrunk on the outside of them. In the other the presses are made of steel hoops piled upon one another and rabbetted together, water-tightness being secured by a copper lining or bag, on much the same principle as the ordinary double-tube bicycle tire, the hoops providing the strength, and the copper lining the tightness.

The presses of the Canadian locks are made of plain steel castings, built up similarly to the rams. This method has proven eminently satisfactory in the tests, and in practical operation it leaves nothing to be desired. The internal diameter of the castings is 7 ft. 8½ ins. The thickness of the metal is 3¼ ins., and the length of the sections 5 ft. 3 ins. The sections are flanged at both ends. The flanges are faced and rabbetted male and female. The corresponding faces of the rabbets are also corrugated male and female to receive a soft copper gasket, similar to that used in the

ram. In addition to the copper, a lead gasket is also used in the press joint, placed in a V-shaped groove cut in the flanges about three inches outside the circle of the copper gasket. The lead was put in round, ½ in. in diameter, and distorted to nearly fill the groove in the process of making the joint. Fifty-six bolts, 1⅝ ins. in diameter, were used in each of the press joints.

The top of each press is finished with a stuffing box of rectangular form, 1 in. wide and 10 ins. deep. This box contains twelve rings of braided hemp and tallow packing, which, before using, were about 1 in. square. The hemp is tightened down by a steel gland or follower with thirty-six stud bolts tapped into the top section. Each press is braced to the walls of the well near the top by adjustable struts, enabling the press to be accurately centered before the erection of the lock chambers began.

The pipe connecting the presses near the top, immediately below the stuffing boxes, is an extra heavy, lap-welded, wrought iron pipe, 12 ins. in diameter, and ½ in. thick. Through this pipe all the water displaced by a descending ram is driven into the other press, causing its ram to rise. Midway between the presses, immediately under the center of the middle tower, a gate valve is placed in the 12-in. pipe, to make connection from one press to the other, or shut it off as occasion may require. The body of this valve is a steel casting. The valve is controlled solely by the lockmaster in his cabin on the top of the middle tower. Besides the main gate valve there are two auxiliary valves, which are operated automatically by the lock during its motion. These valves serve as a protection against possible accident to the gate valve, and each is closed by the chamber on reaching the end of its stroke, the closing being started about the last ten feet of stroke.

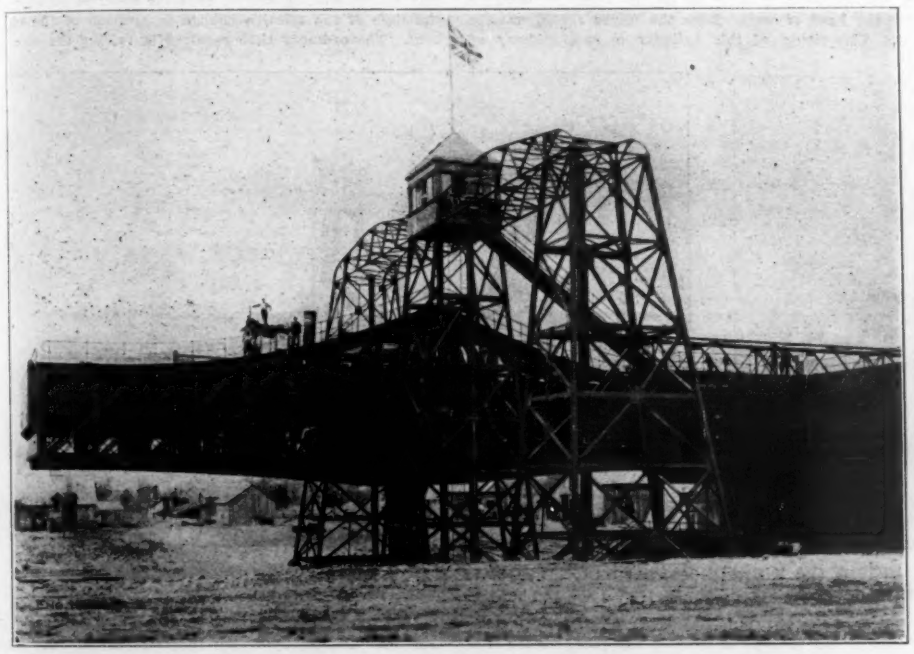


FIG. 4. SIDE VIEW OF KIRKFIELD HYDRAULIC LIFT LOCK.
(Copyright in Canada by R. M. Roy, Photographer.)

HYDRAULIC TESTS.

After manufacture, and before erection, all the castings of the presses and rams were subjected to a rigid hydraulic test at a gage pressure of 1,200 lbs. per square inch, being twice the working pressure. A number of these castings were tested to 2,000 lbs. gage pressure. These higher tests proved so satisfactory that it was considered unnecessary to continue the tests beyond the 1,200-lb. limit. This hydrostatic testing was of absorbing interest, and gave results of importance and value in what was hitherto a practically unexplored field. The higher pressure, 2,000 lbs., gave stresses approaching the elastic limit of the metal, and proved beyond a doubt the perfectly homogeneous character of the castings. When it is considered that the length of a full size tension specimen in the test was over 300 ins. it will readily be seen that accurate and interesting information should be obtained. The normal press and ram sections were ordinarily set up in pairs and connected by a test-head ring bolted up with temporary gaskets at each end. The hydraulic pressure was applied. The pressures were recorded by at least three hydrostatic gages of standard make, and accurate notes were made of the rate of loading, pressures, extensions, and all other information that might affect the results. The extensions of the steel castings were measured circumferentially by five steel tapes spaced equally up and down the casting. The tapes were accurately located and held to a constant tension by steel springs. The extensions were measured by a vernier, graduated near one end of the tape, and matching a corresponding scale graduated at the crossing point near the other, so that readings could readily be made to the 1-100 part of an inch. The readings in all cases showed the greatest extension circumferentially on the middle tape, the extension decreasing gradually towards the flanges, where it was practically zero. The tape measurement also clearly showed which end of the casting had been uppermost in the mould when it was poured, the lower, and consequently the denser end, invariably showing the least stretch. Probably the most remarkable result obtained in the whole of the forty-four tests conducted was that on casting No. SB1, where the gage pressure was run up to 2,200 lbs. per sq. in. This pressure caused, in the walls of the casting, an average stress of 29,100 lbs. per sq. in., and the middle tape showed an extension of 1½ in. The permanent set resulting from this pressure was 1 3-16 in. circumferentially.

In order to study the effect of annealing steel castings the founders, The Penn Steel Casting and Machine Co., of Chester, Pa., offered to anneal a casting in order that we might subject it to a similar test. The test was applied with eminently satisfactory results. The extensions increased directly as the load. At 2,000 lbs. per sq. in. the elastic extension was only ¼ in., and the permanent set was found to be practically zero. This proved conclusively that the annealing of the steel castings relieved the initial strains in the walls entirely, and left the metal in its theoretical condition.

The results obtained on the cast-iron ram sections are no less interesting. They showed that in castings of this size the absence of a limit of elasticity in compression for cast-iron cannot be ignored. In every instance, in the first twenty-four tests, a permanent set was obtained, and this permanent set was almost in proportion to the applied load. The deformations of the cast-iron sections were measured on diameters by means of ordinary high-grade inside micrometers reading to 1-1000-in.

The temporary gaskets used during the tests were generally of leather, which appeared to adapt itself readily to the variations of the specimen during the test. In order to prove the tightness of the permanent gaskets, certain of the sections were set up two stories high, the middle joint being made in exactly the same manner as the final joint in the field. This gasket proved itself absolutely tight at double the working pressure.

It was anticipated that considerable difficulty would be experienced by the porosity of the steel and iron castings. The tests showed the steel castings to be absolutely tight, while in a few cases the iron castings showed slight traces of oozing at the higher pressures. In these instances the tests were discontinued, and the sections allowed to stand two or three days under the pressure of compressed air at about 40 lbs. gage pressure, when the tests were again resumed. In every case it was found that the intervening time had given the iron castings ample opportunity to tighten themselves. The tightening was probably due to the formation of oxide in the pores of the casting, which effectively closed these minute passages against the entrance of water.

The conclusions drawn from the whole series of tests on the presses were: 1st, it is possible to obtain steel castings in this form absolutely impervious to water up to 2,200 lbs. gage pressure; 2d, it is possible to get castings in which no flaws exist; 3d, that a slight permanent set occurs at about 300 lbs. gage pressure, although part of this may be due to the self-adjusting of the tapes; 4th, that this permanent set is not increased appreciably by pressures up to 1,200 lbs. gage pressure, or by repeated applications of the same. The foregoing conclusions apply to unannealed castings. The annealed castings possess all the virtues above referred to, with the addition of no permanent set up to 2,000 gage pressure.

In the cast-iron sections for the Peterborough lock the permanent set in compression had to be allowed for by making the diameter of the sections slightly larger beyond the flange influence. The tests invariably showed a distortion, as diminution in diameter, which left the sections with theoretical size.

PRESS AND RAM ERECTION.

The erection of the presses was conducted through the winter season. The pieces, which averaged about 10 tons each, were handled and lowered with a stiff-leg derrick run by a steam hoist. A very ingenious method was adopted for the erection of the rams. After each press had been completed, the opening for the 12-in. cross-over pipe was closed with a temporary cover, and the press was filled with water to the top. Then the base of the ram was entered into the press, the weight being still held by the derrick. As soon as the packing was placed and the gland screwed down, the derrick hooks were taken off the ram, which was then supported on the confined water within the press. The next ram section was brought and placed upon the base, and after the joint with the base had been finished, water was permitted to escape from the press until the ram settled down through the stuffing box the length of the section. In this manner the ram sections were successfully placed and immersed one at a time until the top section was in position.

GENERAL ERECTION.

The erection plant for the superstructure was a very complete one. A railway siding was run up to the side of the lock, and all the material was handled by 15-ton stiff-leg derricks of the simplest design. All field riveting, reaming, and caulking was done with compressed air furnished by a 55-HP. compressor run by steam, and conveniently located beside the pits. While referring to the erection plant of the contractors, it will not be out of place to make a brief reference to the many ingenious and original devices adopted to carry out the work. As many of the operations required numerous repetitions, the application of time and labor-saving machinery was of importance. Among these may be mentioned the appliances for handling the large press and ram sections. Built steel balance-beams were made for regular lifting by hooks under the flanges, while operations of turning over were accomplished in a few minutes by suspending the sections on trunnions held on the middle diameter of the casting.

For transporting the Kirkfield castings over a country road in the summer time, a 15-ton roller-bearing steel wagon was built, with 10-in. tires and 6-ft. gage. With three teams hitched thereto the castings were transported with perfect ease. Probably the most ingenious device of all is a pneumatic wrench for screwing up nuts on bolts up to 1⅝ in. in the large presses and rams. This machine, which consists essentially of an oscillating, double-acting air cylinder, the piston of which rotates a box-wrench through the medium of a ratchet, weighs about 70 lbs., is handled by two men, and does the work of twenty-five in the same time and in a more satisfactory manner.

THE AUXILIARY PLANT.

The auxiliary plant in connection with the Peterborough lock consists of a hydraulic accumulator with its accessories, two hydraulic gate-engines, two hydraulic capstans, an air compressor, an air water-lift, and a deep-well pump. Provision has also been made for the installation of a lighting dynamo.

The duty of the accumulator is to supply water under pressure to the main presses for the purpose of making good any slight leakage of the large glands or the adjustment of the relative height of either chamber. It also supplies power to the gate engines and to the capstans. The ram of the accumulator is 20 ins. in diameter, with a working stroke of 30 ft. 6 ins. The working pressure is 640 lbs. per square inch. The accumulator is installed in the east side tower, and obtains its water supply from one of a duplicate pair of pressure pumps in the pump room. These pumps are operated by a 15 in. horizontal "Crocker" type turbine driven under 65 ft. head by water from the upper reach of the canal. The accumulator differs from the regular type by having its ballast box directly on top of the ram instead of the usual annular form, the advantage so gained being an efficient bracing of the accumulator press to the surrounding walls of the tower.

The pressure pumps are of the three-throw type, single acting, having 4½-in. bronze plungers, and are geared down from the turbine. Two pumps are provided, either

of which may be used under ordinary circumstances, or, if necessary, both may be connected. The accumulator automatically regulates its motive power.

One three-cylinder hydraulic engine operates the lower gates, and a similar one works the upper gates. One hydraulic capstan is on the lower level and the other on the upper. The gate engines and capstans are all actuated by the accumulator.

The air compressor, built under the patents of the Taylor Hydraulic Air Compressing Company of Montreal, is in a void in the breast wall. It gets it supply of water from the upper reach. The air to be compressed becomes entangled with the water passing through a peculiarly constructed headpiece at the point of inlet, and is then dragged down by the water to a depth considerably below the elevation at which the water escapes, being collected at the lowest level and thence delivered for use. The bottom of the headpiece is about 10 ft. below the surface of the water, and is connected by an 18-in. down-pipe, with a collecting tank 85 ft. below it. The down-pipe descends in a 42-in. shaft, and the tank, 11 ft. in diameter, is in a chamber 14 ft. in diameter. As the collecting tank is bottomless, and on legs raising it 6 ins. clear of the floor, the water, after leaving the air bubbles collected in the top of the tank, rises in the 42-in. shaft and escapes through an outlet about 17 ft. below the inlet level. The imprisoned air in the collecting tank is under the pressure due to the column of water from the water line within the tank to the point of escape, which in this case is about 28 lbs. per square inch. From the collecting tank the air is conveyed by pipes to the pump room, and from there to the seal tubes to be used for inflation, and for pumping. The capacity of the compressor is 300 cubic feet of air per minute.

power in both cases is very similar, consisting, speaking generally, of a small turbine, a pressure pump, and an accumulator, the latter, as in Peterborough, being the direct source of power for the gate machinery and capstans.

The Kirkfield Hydraulic Lock.

At Kirkfield the chief departures from the design of the Peterborough lock consist in having three steel towers instead of three concrete ones; steel aqueducts for the upper gateways instead of the heavier concrete breast wall; and a much simpler auxiliary plant for operating the gates, capstans, and pumps. The truss work for the chambers is almost identical with that of Peterborough. The gates are likewise of the same type. The manner of operating them, however, has been modified to overcome the difficulty experienced at Peterborough from floating chips and driftwood becoming entangled in the teeth and chain of the gates and rack.

For the gate operation, a simple high-pressure cylinder is the motive power. The end of the piston rod terminates in a rack which, through a segmental gear, imparts a rotary motion to the main shaft, to which heavy steel levers are fastened, this shaft being 57 ins. away from the axis of the reach gate. The outer end of the levers engage with the reach gate, which is automatically connected to the chamber gate, and open and close them by the motion in one direction or the other of the actuating hydraulic cylinder.

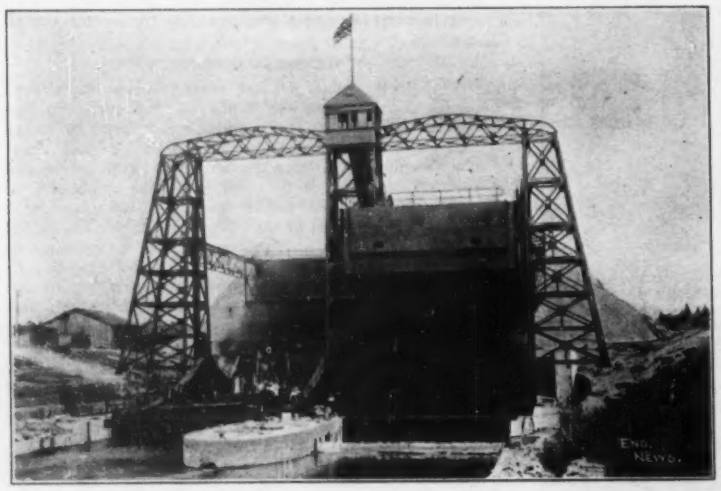
The main auxiliary plant at Kirkfield consists of a pair of intensifier pumps, either one of which is capable of doing the required work. These pumps have been specially designed for this lock. The engine end consists of a double-acting cylinder 40 ins. in diameter, working under the head of water from the upper reach, namely 50 ft. The piston of this cylinder is cast midway of the length of the piston rod, which is 6 ins. in diameter, the ends of the piston rod forming the plungers for the high pressure end. The stroke is 24 ins. These pumps work automatically and, as well as regulating the large presses, furnish the motive power for the gates and capstans. The capacity of each pump is 50 imperial gallons per minute.

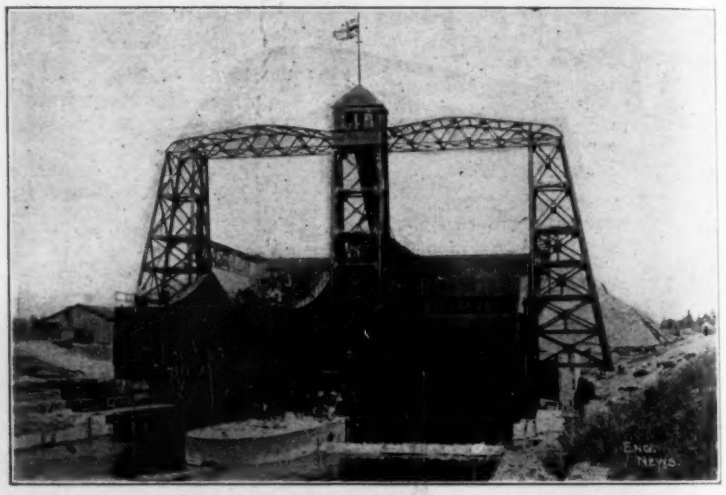
The contract for the superstructure of the Kirkfield lock is $297,300.

The Kirkfield lock is located on a gradual rock slope. The upper approach consists of concrete side walls built upon the rock, and terminating on the east side of the roadway at the breast wall. From the breast wall steel aqueducts for the upper gateways extend to the end of the lock chamber, and are supported by heavy steel columns standing in the bottom of the pit. The pit is excavated entirely in the rock, the sides having been cut with a Sullivan Channeller, and left with the machine face exposed. The rock is of a much better quality than that encountered at Peterborough.

convenient of access to the gatemen. The interlocking system is so arranged that the lockmaster must set his levers in proper order, and these having been set, neither he nor the gatemen can err by using their levers at the wrong time.

In order to get a clear idea of the complete mode of operation, let us assume that both lock chambers are down at the lower level, empty, as they are at the end of the winter, or when it is desired to prepare them for navigation purposes. The annular space in each of the presses if empty will be filled with water. The main valve on the connecting pipe will be closed and water will be pumped into one of the presses until the ram, with its superimposed chamber, rises to the level of the upper reach. An examination of the case will show that it is necessary that the uppermost chamber, in order that it shall be able in descending to cause the other to take the full upward stroke, must contain a volume of water greater than the rising chamber contains. This extra amount of water is equal to the volume of one of the rams, since the change that takes place during the relative motion of the two chambers is that the ram of the descending chamber becomes constantly immersed while the other protrudes. In other words, the descending chamber is losing weight while the ascending is constantly becoming heavier. It is also necessary that some extra weight be provided to overcome the friction of the guides and of the stuffing boxes of the main presses. The area of each lock chamber is so great that it requires only an additional depth of 8¼ ins. to give an extra load of water of 100 tons, which is sufficient for ordinary operation. The addition to this weight will, of course, have the effect of accelerating the time of the relative change in position of the chambers. The ordinary time required in raising the chamber through the whole elevation is about two minutes. But this will depend upon the adjustment of the main glands, the nicety of the working of the guides, and the manipulation of the main valve in the hands of the lockmaster.





FIGS. 5 AND 6. VIEWS OF KIRKFIELD LIFT LOCK FROM LOWER LEVEL.
(Copyright in Canada by R. M. Roy, Photographer.)

The air lift, which is entirely automatic in its operation, and receives its air from the Taylor air compressor, is somewhat of a novelty, and in connection with the compressor it is very economical and convenient under the existing circumstances. Its duty is to keep the lock chamber pits free from water, which it does by pumping from one of the wells in which the drainage is collected. This device consists of a simple pipe submerged in the water at the suction end, where compressed air is admitted to it. The discharge pipe is 4 ins. in diameter. At the inlet it is 3½ ins., and extends 35 ft. below the surface of the water in the well. The suction or inlet is in the form of an inverted funnel, 16 ins. diameter at the large end. At this point a small quantity of compressed air is admitted, and becoming mixed with the water in the pipe, makes a column of air and water, which rises by virtue of its being lighter than the water surrounding the pipe. The actual lift is 29 ft. from the water line in the well to the water line at the discharge in the lower reach.

The European Locks.

The LeLouvière lock has a double cantilever truss work for the chambers, on much the same principle as the Peterborough lock, excepting that the trusses are only 19 ft. deep at the center, as compared with 32 ft. in Peterborough. The guide towers, nine in number, are of steel, and the upper gateways are contained in a steel aqueduct.

At LesFontinettes the lock chambers are supported by plate girders, the webs being made use of as the side plating of the chambers. The guide towers are of brick, placed on the transverse center line in a manner corresponding to those at Peterborough.

In both these locks the clear-head room above the water is required to be only about 9 ft., and in consequence the gates in both cases are raised vertically by means of an overhead gantry frame. The auxiliary

OPERATION.

The operation of the hydraulic lock requires three men—a lockmaster and two assistants, or gatemen. The lockmaster is in charge and is responsible for the structure. Two gatemen are required, one at the lower end and the other at the upper, to open and close the gates, to inflate or deflate the seal tubes, and to operate the capstans. The gatemen also take charge of vessels at about 200 ft. on either side of the lock. The lockmaster, during operations, stays in his cabin on the top of the center tower and has full view of all that transpires. He is also in communication with his two assistants by a simple signal system. The lockmaster has before him the principal levers, and through an interlocking system regulates the working of the lock. The levers for controlling the gate engines and the capstans are situated on the wall immediately above the respective machines.

An ordinary lockage is conducted in this manner: Suppose 100 tons of "surcharge" has been found to give sufficient additional to the descending chamber. The uppermost chamber will then be required to stop with its floor 8¼ ins. lower than the bottom of the upper reach. On communication being established with the reach, it receives from the reach 100 tons more than the lower chamber contains, assuming the depth in both reaches to be the same.

Then the total operations to make the lockage, if the gates adjoining the reaches are opened and the seal tubes are inflated, consists in hauling the vessel into the chamber and mooring her there securely, closing the gates, deflating the seal tubes, and opening the main valve between the presses. The heavier chamber then commences to descend, the motion being allowed to increase gradually by the gradual opening of the valve until it reaches the maximum speed. At about three-quarters of the stroke the main valve is slowly closed, communication between the presses being entirely cut off when the end of the journey is reached. The change in elevation being made, the seal tubes are inflated, the gates are opened, and the vessel or vessels are free to go on their journey, after being towed out by the capstans. The "surcharge" contained in the descending chamber simply flows out into the lower reach, while a similar quantity to perform the next lockage is admitted into the chamber which has just reached the higher elevation.

The record lockage, so far, at the Peterborough lock is 6½ minutes, being the whole time from the stopping of the vessel in the lower reach to her proceeding on her journey under her own steam in the upper one.

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In connection with the recent discussion in these columns of Employers' Liability legislation, it may be of interest to know what is the average rate of loss due to accidents and injuries to employees for which employers are held liable in damages. We find in the "Monthly Bulletin" of the Fidelity & Casualty Co., of New York City, a record of the experience of several of the principal companies which write Employers' Liability insurance. The record covers the years from 1893 to 1900. Later statistics are not yet available. It appears from these figures that taking the United States as a whole and the average of all classes of occupations, the average loss per $100 of wages paid was as follows:

Year.	Average loss through employer's liability per $100 of wages paid.
1893	25.5 cts.
1894	27.6
1895	28.5
1896	29.9
1897	31.9
1898	33.6
1899	37.7
1900	36.2

These figures show a gradual increase in the rate of loss, and it is claimed that this increase is due chiefly to legislation and judicial decisions, which tend to increase the liability of employers. It should be added that the above is the average of all occupations, and the percentage of loss is stated to be greater for contractors than for manufacturers.

It will be understood, also, that these figures represent actual losses and not the premiums which must be paid to an insurance company for bearing the losses. The insurance company must, of course, charge enough more than the average actual loss to cover the cost of carrying on its business and to provide a reasonable margin of profit.

After allowance is made for this, however, it is evident that employers can afford to insure themselves against losses from accidents to employees and that the cost of so doing should be no serious burden on any legitimate business. If we take the loss rate as high even as 40 cts. per $100 of wages paid, it would amount on an establishment employing 200 hands and paying them an average wage of $500 in the course of a year, to only $400 per annum.

In the same journal we find a statement by President Geo. F. Seward, head of the Fidelity & Casualty Co., commenting on the recent address of President Roosevelt on Workmen's Compensation Laws, printed in our issue of June 13. As Mr. Seward is an expert on the question, his remarks are of special interest and we quote as follows:

There is no possible doubt that under the system of what may be called workmen's compensation, the cost of accidents to employers will be very considerably greater than when the provisions of the law in regard to negligence are made the basis of payments. There can be no doubt, either, I think, that workingmen would vastly prefer the compensation system, and, probably in the long run, employers would also, because under the compensation system they would be saved, more or less perfectly, from damage suits, and they could more readily estimate what the charge for injuries to employees would amount to. In either case, employers could get insurance against their losses.

The fact that in the European States the system of workmen's compensation has been adopted affords very good evidence that it is a right system. It may very well be said that it is not altogether creditable to legislative bodies in our own country that no great progress has been made by them in the same direction.

When one considers how this reform can be brought about, he is unable to see that much could be done by national legislation. Matters that affect employers and their servants are subject to State regulation and not to national legislation, excepting as respects a very limited department.

The State of Illinois some time since appointed a commission to consider such matters. This commission proposes to give to the employee the right to contract with his employer so as to yield his right to recover damages for negligence. The act proposed provides the scale of compensation which is to be paid by the employer to his employees when they are injured, irrespective of any question of fault. Whether the legislative body will consider that it can promote the purpose of the commission by following these suggestions remains to be seen. If it shall do so, and the courts sustain the law, the way will be clearly shown for the introduction of similar laws all over the country. It seems to me that every humane man is likely to hope that the Illinois plan may prove successful.

Nearly a year has passed since ill-founded stories alleging the failure of the slow sand water filters at Washington, D. C., began to be circulated in the daily press, but echoes of these stories are still heard. Thus, under the title, "Increasing Distrust of Water Filtration," the Minneapolis "Tribune" (June 30), says, in part:

Though filtration seems to have worked admirably in small cities of New England and the Middle States, professional and public judgment is still suspended in relation to it for great cities like Washington and Philadelphia.

We do not know what has been done in other large cities like Louisville, St. Louis and Pittsburg that were considering filtration plants. But we suspect that the people of Minneapolis are rather grateful to the business men who blocked the bond issue in the state legislature.

It will be time enough for us to go into filtration here when it has succeeded in larger cities.

From the concluding paragraph of the quotation it would appear that the Washington situation is being used (perhaps by interested parties) as an argument to further delay the movement for the purification of the Minneapolis supply, begun some years ago. As many of the readers of Engineering News know, the stories regarding Washington have been skillfully circulated in other cities sometimes to defeat the adoption of any plan of water purification and sometimes to throw the balance in favor of mechanical rather than slow sand filtration. Reference to the article and editorial published in our issue of July 4, 1907, will show how little basis there is for any such arguments.

The Minneapolis paper above quoted professes entire ignorance as to what has been done in Louisville, St. Louis, Pittsburg and other large cities which it has heard were once considering filter plants. We can furnish it the information, and we trust it will spread it before the readers, who are entitled to know the facts.

Louisville has its filter plant completed or near completion. Pittsburg expects to have its filters in operation by fall, and St. Louis is continuing to use coagulation and sedimentation to clarify its water, and at the same time greatly reduce the bacteria in the water. Cincinnati's great filtration plant is well advanced toward completion. Minneapolis need not wait a day longer to learn whether or not filtration is a success. That fact was demonstrated decades ago, and professional judgment regarding it is unanimous. Public belief in its efficiency is delayed only to the extent that the public lacks correct information, which it is the duty of the newspaper press to supply.

The regulation of discussions at the meetings of technical societies is a problem that is encountered to a greater or less extent by every one called to preside over such meetings. The ends desired are: 1. To induce active participation on the part of men competent and qualified to discuss the subject under review; 2. To confine the remarks to the technical aspects of the subject; 3. To keep the discussion directly to the subject, and not allow it to diverge into side issues and irrelevant matter; 4. To restrain speakers who are prone to self-advertisement and who attempt to talk upon subjects on which they are not able to instruct or interest the audience. It is too often the case that the man qualified to discuss a subject will remain silent or make merely perfunctory remarks, while men who have little or nothing of value to say occupy valuable time in saying it.

Of course it is difficult to know at the outset what is to be the trend of a speaker's remarks, and unless a presiding officer is content to let matters take their course, he often has an anxious time trying to bring the right men forward and keep the light-weights in the background. The task is a difficult and delicate one, especially as one must avoid offending or checking those who may not be ready speakers, but who may have something to say well worth hearing.

A time limit for each speaker is often tried, but is rarely enforced and is really not of great use, as it may give too little time for the man who can really discuss a subject in an interesting manner and too much to the man who is merely talking. The evil in irrelevant discussion is not merely the waste of time but also the effect upon the audience, which is apt to become so bored as to be in no mood to give proper attention to really valuable remarks made by later speakers.

While much depends on the presiding officer, much also depends on intelligent work by the Secretary or other principal executive in arranging the program beforehand and seeing to it that the men best qualified to conduct the discussion are there to take part. The membership, too, must do its part. When those who are able to speak with authority neglect to do so, the opportunity is opened for the chronic bore to rise on his feet and secure recognition from the chairman.

THE WEAR OF THE INTER-TIDAL SPACE ON CONCRETE MARINE STRUCTURES.

A recent letter from a correspondent who has had charge of much of the bridge work on the New York, New Haven & Hartford R. R. between New York City and New Rochelle brings up a new and interesting phase of the concrete question. A portion of the letter reads as follows:

Have you ever discussed the disintegration of concrete where exposed to action of tides? We find a disintegration between high and low water lines evidently due to sewage and mill refuse, and are using stone in preference to concrete at Pelham Bay and Bronx River Bridges. The concrete piers on the old City Bridge at Pelham Bay show considerable disintegration near low water line.

Is concrete, exposed to the alternate wetting and drying and accompanying extra wave impact between high and low water stages of a tidal river or the ocean, subjected to some physical or chemical action which will tend to disintegrate it? We know that timber in a similar position will eventually fail, but timber is an organic substance peculiarly susceptible to physical changes from contact with water and air in succession. In addition, as suggested by the above quotation, has the presence of sewage or trade refuse any effect on concrete in such a position? These questions are becoming more and more pertinent as the use of concrete in tidal waters is growing, and cannot be settled by the mere statements of some enthusiast who claims as did one at a recent convention that "concrete

will stand anything except nitroglycerine in an explosive state," nor by the pessimists who argue the total depravity of the material from one example of unexplained deterioration.

Before any discussion of the structural value of concrete can be entered into, the variable nature of the material must be considered. Unlike the materials for which it is generally substituted, wood and stone, it is an artificial compound depending for its structure on the care and intelligence with which it is made. Any rules which are to be formulated regarding its behavior under certain circumstances must always be more or less dependable upon the elements of its manufacture, which are never assured. It is possible to make good concrete; more and more of it is being made with the spread of the recognition of the worthlessness of poor concrete, but the fact that only the very best concrete that can be made will satisfy certain conditions does not justify specifying concrete where those conditions exist. The behavior of the average material is the criterion by which its use should be regulated.

There are some places where a mediocre concrete can be used, but submerged work is not one of them. The principal thing noticeable in all discussions of the use of concrete under water is the fact that the best material must be used to ensure success. It therefore goes without saying that every precaution must be taken in this class of construction to make every portion of the work of the highest grade so that, even with the unavoidable lowering of care which must occur at certain places, the average grade of the concrete will be much higher than in many other kinds of construction.

In the first place it seems well established that with only ordinary precautions to secure a non-porous mixture, concrete immersed in fresh water is structurally as safe a material as any other masonry. Its status in sea water is not so certain. Many investigators, M. Le Chatelier is probably the best versed on the subject, have studied this action and have reached the conclusion that still sea water contains certain salts which, if allowed to penetrate the thin exterior coating of a concrete surface, enter into combination with the calcium ingredients of the cement, forming salts the crystallization of which gives rise to a swelling and cracking of the mass. If the concrete is of a porous nature or under a great head of water the entrance of the water into the interior of the mass is more easily accomplished and disintegration ensues. This, of course, is an extremely slow process and, in spite of the theories, not always evidenced by the facts. From the few observations which have been recorded, examples can be found to support the most radical arguments for and against the use of concrete in sea water. Those who defend concrete for this purpose have a little the better of the case because they can always fall back on the argument that in instances of failure poor workmanship and material were to blame.

However, the question under discussion is somewhat more restricted. If sea water does have some effect on immersed concrete, are there certain conditions present on a concrete wall between the high and low water stages which will tend to make that portion deteriorate?

There do exist a few differences in the conditions of the inter-tidal space and the totally immersed portion of a concrete structure which may cause different effects on the two. Admitting that a hard, non-porous concrete is comparatively safe against any harmful action of sea water, or in fact any water not polluted with an extremely acid compound, the position of the inter-tidal space is peculiarly situated to destroy any density or hardness of surface which may have existed in the concrete as built, and which is the chief defense against any destroying action. The force of wave action, not only in the water itself as it continually batters against the upper surface, but also in carrying any objects such as are continually floating around a harbor, tends to break and destroy a good surface finish. The finish once penetrated, the action of the sea water can have full play against the interior of the concrete and the reinforcement.

The continual danger of abrasion of the surface by shipping is present, especially in that portion of the work near the water line. This is an effect which is readily discovered and not easily confused with the other forms of deterioration. It is well to note that Mr. F. E. Wentworth-Shields, M. Inst. C. E., of the new dock works at Southampton, recommends that if reinforced concrete be used for marine work it must be carefully fendered at all points where it is likely to be struck.

Alternate freezing and thawing is another probable source of increased inter-tidal damage. Not only is the physical effect of a constantly moving bed of ice against a concrete surface destructive, but the expansion of water which gets into an opening at high tide and freezes at low is sufficient to destroy the surface finish and perhaps to expose the reinforcement. Some years ago there was a discussion of such effects in Engineering News by certain engineers of Canada where the extremely low temperatures should show results of interest along this line. The then Chief Engineer of the Province of Nova Scotia reported that out of 320 highway bridges with concrete substructures, some as old as 15 years, one only had shown signs of deterioration, although some were built in the Bay of Fundy with its 50-ft. tides, and all were exposed to heavy drift ice and to extremes of climatic exposure. The one failure was supposed to have been due to poor workmanship. In this same discussion the Chief Engineer of the Intercolonial Railway of Canada said:

> In piers, abutments and dock walls between high and low water marks in tidal waters, concrete *surfaces* are not proving satisfactory in places where exposed to alternate freezing and thawing between tides in winter and to wet and dry conditions in summer.

Particular emphasis was laid on the words "concrete surfaces" as investigation failed to show any injurious effect upon the body of the concrete.

In view of the great number of concrete sewer conduits, septic tanks and other sewage disposal plants which are in constant contact with raw waste and sewage without detriment to the material, it is hard to see how such pollutions, in the dilute state in which they must be in any river or harbor, can have any deleterious effect on a well-made concrete. Whatever damage would be caused by a sewage-polluted stream would seem to be due to the action of the water itself unless the pollution is to such an extent as to cause a high acid content in the water, in which case the evil effect would be found on stone masonry as well as concrete. In a polluted tidal stream, however, the scum which floats on the top and rises and falls with the tide, is in such a concentrated state that should any weakness in the concrete be present failure would be more likely to occur in this tidal range than in the lower portion where the pollution is more dilute.

The use of concrete for piers, wharves and seawalls is developing at a rapid rate. In Europe especially has this phase of concrete construction been exploited. The time is coming when we can get authentic data regarding the relative long-time wear of concrete and stone masonry in sea water and polluted streams—data which up to the present time have been fragmentary and generally unsatisfactory. It should be the duty of every engineer of experience in this line of work to report the condition of such structures so that information might be available upon which to base a reasonably accurate account of the behavior of concrete under these peculiar conditions. In the present state of knowledge of the subject, only the most general theories can be developed and sufficient evidence can be adduced for the most fulsome praise or most utter condemnation, according to the predisposing opinion of the theorist.

LETTERS TO THE EDITOR.

Another Form for Pile-Driving Records.

Sir: I noticed in your paper for May 30, 1907, a form of Pile Record Card submitted by Mr. Thos. W. Cothran and used on the Norfolk & Southern R. R. Accompanying this letter is a permanent form of record card and also a "Daily Record Card" which I have devised for use on this work and which has been found very satisfactory. It may be of use to some of your readers as a suggestion.

Yours truly, Tyrrell B. Shertzer,
Resident Engineer, Vaughan's Bridge.

Portland, Me., July 1, 1907.

[These cards are in the usual 5 × 3-in. size suitable for filing in a card index.—Ed.]

PORTLAND BRIDGE DISTRICT COMMISSION.

RECORD OF PILES DRIVEN.

Pier_____ Number of Pile _____

Abutment_____ Observer_____ Date_____

Length of Pile_____ Feet. Depth Driven_____ Feet. Number of Blows_____

Penetration by own Weight_____ Feet. Penetration Last Blow_____ Inches.

Remarks_____

OVER FOR RECORD OF BLOWS.

A PERMANENT RECORD CARD.

Is it Safe to Imbed Electric Light Wires in Reinforced Concrete?

Sir: Recently I was present at the removal of an inferior concrete floor or slab about 4 × 9 ft. and 4 to 5 ins. in thickness. The concrete appeared to have been well mixed and with sufficient reinforcement to endure much heavier loads than had been placed upon it during its three years' service. The concrete was said to have been made of 1 part Portland cement, 2 parts river sand and 2 parts gravel that would pass a 1½-in. ring, well mixed by hand and firmly tamped into place, the time required for the entire slab being less than 2 hours.

The reinforcement consisted of quarter-inch round

No. of Blows	Drop Feet	Penetration	No. of Blows	Drop Feet	Penetration	No. of Blows	Drop Feet	Penetration
1			43			85		
2			44			86		
3			45			87		
4			46			88		
5			47			89		
6			48			90		
7			49			91		
8			50			92		
9			51			93		
10			52			94		
11			53			95		
12			54			96		
13			55			97		
14			56			98		
15			57			99		
16			58			100		
17			59			101		
18			60			102		
19			61			103		
20			62			104		
21			63			105		
22			64			106		
23			65			107		
24			66			108		
25			67			109		
26			68			110		
27			69			111		
28			70			112		
29			71			113		
30			72			114		
31			73			115		
32			74			116		
33			75			117		
34			76			118		
35			77			119		
36			78			120		
37			79			121		
38			80			122		
39			81			123		
40			82			124		
41			83			125		
42			84			126		

Reverse of Permanent Record Card.

rods spaced 8 ins. c. to c. both ways, it being the usual two-way reinforcement. These rods were placed 1 in. from the bottom side of the slab, and in no place was there any indication of defects. The centering was not removed for at least five weeks and the greatest load ever placed upon the slab would not exceed 150 lbs. per sq. ft., yet lengthwise through the center (somewhat diagonal) two breaks appeared which continued to enlarge until the fractures connected with each other and extended to the edges at all sides. The first visible crack was noticed about two years after the slab was made and during the last year disintegration was rapid.

In removing the work, two electric arc lamp wires were found imbedded in the center of the slab directly under the two large breaks mentioned above. The insulation on these wires was loose and shelly. In a few places the concrete was in direct contact with the bare wires, and at each of those places a yellowish deposit, not unlike ochre, and equally as soft was found. Three arc lamps connected with these wires gave the lineman no end of trouble the past few weeks, which ended with the removal of the concrete slab, the flickering having disappeared.

This is my first experience of this nature, nor have I heard of a similar instance, but I feel thankful that I have never allowed electric wiring to be imbedded in concrete in any work under my supervision.

Should any of your readers have a similar experience I would be pleased to hear from them, as I am told that a number of reinforced concrete buildings have the lighting wires imbedded in their floor slabs.

Fred W. Hagloch.

Box 431, Pittsburg, Pa.

[It seems to us very unlikely that the electric current itself caused any injury to the concrete. The insulated wires would themselves cause a weak place in the concrete, for the concrete would not adhere to the insulating covering as it would to metal, and even if it did, the insulating material has little mechanical strength. The bare spots on the wire where the yellow deposit was found were merely places where the rubber insulation had crumbled to dust.—Ed.]

PORTLAND BRIDGE DISTRICT COMMISSION.

DAILY REPORT OF PERMANENT WORK.

Location of Work _____ Date _____

Dredging _____ cu. yds. _____

Piles Driven _____ lin. ft. _____

Grillage _____ ft. B. M. _____

Concrete _____ cu. yds. _____

Cut Stone _____ cu. yds. _____

Steel _____

Filling _____ cu. yds. _____

Rip-Rap _____ sq. yds. _____

Pavement _____ sq. yds. _____

DAILY REPORT ON PERMANENT WORK TO BE TURNED IN AT END OF EACH DAY'S WORK.

What Is It Worth to Avoid a Curve in Railway Location?

Sir:—In the article on "Train Resistance and the Economics of Railway Location" and your editorial comment on same, in the issue of May 16, it seems to the writer that one very important factor has been overlooked: that is the value to be placed on a curve independent of the amount of central angle.

Without doubt many accidents are due solely to a change in direction of line, and there should be some economic value given to this change to assist in making an economical location.

It has been the writer's practice to combine angles where it could be done, even at some additional expense, in order to reduce the number of curves, although he has had to be guided only by judgment in each particular case as to how much expense would be warranted to obtain this end. It would be interesting, no doubt, to many locating engineers to know just how much value to place on a curve independent of the angle, if there is such information obtainable.

Very truly,

W. W. Amburn.

422 Abingdon Building, Portland, Ore., June 26, 1907.

[Twenty years ago, the late A. M. Wellington wrote in his monumental treatise on Railway Location:

The prevailing error in respect to curvature among engineers is too great dislike of curvature, and especially of sharp curvature, and to a great readiness to spend money to avoid it.

The particular question raised above, that of the increased liability to accidents on account of curvature, was exhaustively investigated by Mr. Wellington. His conclusion was that the actual danger due to curvature is so small that it should be neglected in the practical work of railway location except where other considerations are exactly balanced. Of course these other considerations, such as the ability of fast trains to make time, the added resistance to train movement on curves, the additional cost of track maintenance, and some other matters, are to be given due attention, and this was done by Mr. Wellington in his treatise. The conclusion which he reached was that the total cost per year per daily train of 1° of curvature was 43 cts. With interest at 5% this annual expenditure would pay the interest on an investment of $8.33. This estimate is made on the assumption that the cost per degree is practically the same for a sharp curve and an easy curve; that is, that the additional operating expense caused by 100 stations of a 1° curve was essentially the same as for 10 stations of a 10° curve.

Mr. E. H. McHenry in his rules for Railway Location assumed the operating cost of 1° of curvature at $7 per daily train per annum. This corresponds, we believe, to Mr. Wellington's figure of $8.33 above, and takes into account the much lower rate of interest prevailing when Mr. McHenry wrote.

Mr. Walter L. Webb, in his latest treatise on "The Economics of Railroad Construction," again reviews the elements affecting the cost of curvature and fixes upon 64 cts. per degree of curve per daily train per annum. He changes Mr. Wellington's figures, principally by reason of the great increase in rail wear on curves that has developed since Mr. Wellington wrote.

We are inclined to the opinion that a thorough review of the whole subject, in the light of present day operating experience, would show reasons for a still larger increase over Mr. Wellington's figures. The increase in size of average train alone since Wellington wrote would nearly double his figures. A dollar per degree of curvature per daily train per annum would not seem to us excessive at the present time.

It must be borne in mind, too, that these figures refer to ordinary railways of general traffic, such as come in the ordinary work of the locating engineer. On special lines of exceptionally heavy and high speed traffic other considerations than increased operating expenses may justify a much larger figure as the base rate for use in estimating allowable expenditure to reduce the amount of curvature.—Ed.]

Grades for Steam Shovel Work.

Sir: In steam shovel operation in opening gravel banks or on construction it is often desirable to start the shovel at an elevation considerably above the proposed grade line and to let it cut itself down to grade by taking out successive lifts. In such cases the maximum rate of grade that can be operated for the spotting engine has always to be considered, and has an important bearing on the cost of the work and the time necessary for its completion.

In opening up a gravel pit at Sugar Grove, Ill., on the Aurora Division of the Chicago, Burlington & Quincy Ry., this problem was confronted and a description of the plan adopted may be of interest. To start the work so that it could be conducted economically it was necessary to cut through the ridge of gravel to gain access to the southern face of the ridge. The point selected for cutting through was a "saddle" or depression in the ridge, the highest point of which was 50 ft. above the level of the running track to the pit. As the slope of the hill was at the rate of 25% it was necessary to grade an approach by teams, and after some controversy a grade of 10% for a distance of 400 ft. was decided on.

A cut of 10 ft. was made at the top of the ridge to obtain material for the embankment of the approach. The shovel was "cut in" at the mouth of the cut so made at a point 30 ft. above the surface of the level ground, while the loading track was carried on to the summit of the 10% grade and continued on the other side of the ridge along the surface on a lighter descending grade.

In placing the shovel, two mogul (2 : 6 : 0) engines were used, of 21,000 lbs. and 25,000 lbs. tractive force, respectively. The shovel weighed 65 tons, exclusive of an ordinary locomotive tender for coal and water. Eight 100,000-lb. capacity Rodger cars, weighing 20 tons each, were placed between the engines and the shovel so that the engines would remain on the level track. No difficulty was experienced in setting the shovel at the desired place and the spotting is done by a mogul engine of 21,000 lbs. tractive force handling trains of six 100,000-lb. cars.

In this instance the saving of time was of even greater importance than the amount of money saved, and much of the credit for the plan is due to Mr. F. H. Ustick, Superintendent, whose desire for obtaining ballast quickly led him to favor the scheme which was successfully carried out under the writer's supervision.

Yours truly, F. M. Patterson,
Division Engineer, C., B. & Q. Ry.

Chicago, Ill., June 15, 1907.

COOPERATIVE COURSES IN ENGINEERING AT THE UNIVERSITY OF CINCINNATI.*

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About six years ago the writer began what might be called a pedagogical research into the problem of engineering education. After a time he sifted the problem down to three questions: 1. What requirements should the finished product of an engineering school fulfill? 2. Where and how shall we get the raw material to make the required finished product? 3. Through what processes shall we put the raw material in order to obtain the required finished product?

This investigation has been carried on during these six years (and is still in progress) by visits to the largest manufacturing concerns in the eastern and middle states, in order to obtain from the employers of engineers their views on the subject. In a great many cases the men consulted were graduates of the best engineering institutions in the country.

About two years ago the results of the investigation, up to that time, were compiled and put into a formal paper which the writer intended to present to this association. He was reluctantly forced to certain conclusions by the inevitable logic of the facts gathered; but these conclusions were somewhat radical and revolutionary, and after a thorough consideration of the matter he had not the temerity to present the paper. It seemed to him that an actual demonstration of a system of education which was the natural outgrowth of this investigation would perhaps be the best proof of the correctness of the opinions of the men whom he had consulted. Opportunity was offered for this experiment at the University of Cincinnati, and the Cooperative Course in Engineering now in operation is the result.

This course is so planned that the students taking it work alternate weeks in the engineering college of the university and at the manufacturing shops of the city. Each class is divided into two sections alternating with each other, so that when one class is at the university the other is at the shops. In this way the shops are always full-manned, and thus the manufacturers suffer no loss and practically no inconvenience by the system.

There are two facts on which it is desired to place especial emphasis, so that there may be no misunderstanding about this work. First, the entrance requirements for this course are precisely the same as for the regular four-year course. Secondly, the university instruction under the cooperative plan is just as complete, thorough, broad, and cultural as the four-year course. As a matter of fact, it is broader and more cultural. Let there be no misunderstanding about this. The course is not a short cut to a salary.

The length of the course is six years. During this period the students work alternate weeks in the shops of the city throughout the scholastic year, and in the summer full time. They are given one week's vacation at Christmas and two or three weeks during the summer. The practical work at the shops is as carefully planned as the theoretical work at the university, and in all cases the students follow, as nearly as possible, the path of the machines manufactured, from the raw material to the finished product sold. For instance, at the works of the Bullock Electric Company the students spend the first year in the foundry; the next year and a half in the machine shop; the next two years in the graduate-apprentice course, covering the commutator, controller, winding,

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erecting, and testing departments; and the subsequent time in the drafting-room and sales office. A contract is signed in triplicate by the student, the university and the firm. This contract has a blank space to be filled out with the shop work the student is to receive during his six-year course. In all cases the dean of the engineering college and the professor of electrical, chemical, or mechanical engineering, as the case may be, confer with the manufacturers in planning this course of shop work, so that the young men get a logically and carefully planned shop and business training.

The students are paid for their services on a scale of wages beginning at ten cents an hour and increasing at the rate of one cent an hour about every six months. The rate at which the first class started was lower than this, but on account of the quality of work which the young men did in the shops, the manufacturers made a voluntary increase which is equivalent to about four hundred dollars for the whole course. The student's total earnings in the six years will amount to about two thousand dollars.

Young men desiring to enter this course are required to go to the shops in June or July preceding their entrance to the university. We believe that certain men are mentally, physically, and temperamentally adapted to engineering, and that the process of elimination which comes through this summer work weeds out the weaker ones and leaves a residue which can be depended upon for results.

This course has been in operation for one year, and it will be interesting, perhaps, to observe how the elimination process works. Last year about 60 young men made application for entrance to the course. They were all sent to the shops to observe what the work was like and were asked to report back to the university office. Forty-five returned and began work; 15 of these quit shortly after they began, leaving us a class of 30 last September. Three of these men have been dismissed for poor scholarship.

This year we have had about 400 inquiries and applications for admission to this course, by mail and in person. A great majority of these young men fade away when they learn of the conditions of the course. In the light of our former experience we are using a different method in acquainting the young men with the shop conditions, so that we shall have a smaller proportion of losses when we get them into the plants. Up to this writing 50 men have been placed in the shops for next year's class, and it is probable that by the time the class is filled we shall have between 50 and 75 student-apprentices.

It is interesting to note the reasons which prompted these young men not to apply for work, or if they did apply, to quit work. Some of the reasons were: "It looked too hard"; "I had to get up too early in the morning"; "the work was too greasy"; "I'd rather be a lawyer"; "I want to complete my education in four years instead of six"; "my father said they did not pay me enough"; "my mother was afraid I'd get killed"; "the boss spoke gruffly to me"; and so on. Some of the young men who withdrew from the cooperative course are in the four-year course.

A comparison of the work of the four-year freshmen with that of the six-year freshmen during the past year is worth a moment's consideration. The six-year cooperative students, although working but one-half the time of the regular students, have done three-quarters of the work of these regular students, including all the mathematics and sciences of the freshman year, and their average grades are 25% higher than those of the four-year freshmen. As a matter of fact, they have taken all the university work excepting three hours of English and three periods of shop work, and, of course, they have received much more shop work at the city plants than they would have covered at the university.

This course applies to the departments of electrical, chemical, and mechanical engineering. It has not been found feasible to establish a cooperative course in civil engineering because the local conditions will not permit. The aim of the course is not to make a so-called pure engineer; it is frankly intended to make an engineer for commercial production. The investigation spoken of in the forepart of this paper disclosed the fact that a great majority of the engineering graduates are employed in commercial production, whereas the present college courses do not contemplate anything other than that the college graduate will become a so-called pure engineer.

I regret that limitations of time at this meeting will not permit a further exposition of this course, for the experiences which we have had in one year's operation and in gathering our second class have taught us a great many things which I believe would be of interest. I should like, for instance, to point out in detail some of the following features: The advantage to the student of the extra two years of time for the assimilation of his theory; the effect of his shop work on his theoretical work; the solution of the problem of proper exercise for the student; the knowledge he obtains of the labor problem, and of time as being the very essence of commercial production; the fact that this course resolves itself down to a training in commercial production with a university preparation in the underlying science—for you will note that of the six years, four are spent in practical shop work, and that in the two years' actual time spent at the university the cooperative student gets more than the regular student does in four years.

Attention is called to the fact that we are operating our engineering college at the highest efficiency; for, being given a certain sum of money to train a certain number of men, we are educating only those who by mental, physical, and temperamental adaptability are worthy of the expenditure made.

While there is no cloud on the horizon now, it is possible that a combination of unfavorable circumstances may work harm to the course. But we have operated it long enough to know that under normal conditions it is a good thing.

In closing, I may add that it is believed this system of education will furnish to the manufacturer a man skilled both in theory and in practice, and free from the defects concerning which so much complaint is made. It is not held, of course, that this method of training will supply full-fledged engineers, aged twenty-three years or thereabouts; but it is believed that it will provide a better preparation, a stronger foundation, for the successful practice of engineering. The qualifications which the engineering graduate should possess will be more nearly attained. He will be just as thoroughly grounded in the fundamental principles of science as he is under present conditions, but he will have greater facility in applying them to practical problems. He will be much more highly specialized, but not at the sacrifice of fundamentals. A knowledge of the achievements in other fields of engineering will result from his constant association with the best practice in electrical, mechanical, structural, and chemical engineering, as exemplified in the construction of the cooperating works, in their methods of power generation and transmission, and in their processes of manufacture his attention having been called to these details in the classroom, and his observation of them having been checked by searching questions thereon. He will become familiar with business methods by constant contact with business conditions, supplemented by classroom instruction and practical talks on business law. He will obtain a knowledge of men by working intimately with all sorts and conditions of men in his gradual rise through the various departments of the cooperating plants. The cultural part of his education will be planned to make him a man of good address and broad sympathies.

Finally, a combination of these conditions will teach him to do his best naturally and as a matter of course. It will start him on his life work with a symmetrical and uniform fundamental development which will continue evenly and make him a skilled engineer, a safe business man, and a broadly tolerant and intelligent citizen.

MOSQUITO WORK AND MALARIA IN THE PANAMA CANAL ZONE.*

The prolonged dry season and the comparative lateness of the beginning of the general rains along the Zone have been productive of conditions favorable to the breeding of mosquitoes, which are somewhat unique, and against which this Division has been compelled to adopt measures never before necessary. The principal source of mosquito breeding has been along the course of the Rio Grande, Comacho, Bas Obispo, San Juan, Gamboa, Caraballi and Chagres rivers. As a rule these streams possess sufficient rapidity of current to call for only occasional attention, but during this month all of them except the Chagres have consisted of a series of still pools, connected by a mere thread of trickling water. Under an unclouded sky the temperature of these still pools became so favorable to algae growth that a good crop would spring up after the second day of a thorough cleaning. In the eddies and shallow bends anopheles appeared at once, while the various species of culex abounded at all times.

Oiling such an extent of water was only partly effective, and no sooner was the stream cleared throughout its length than it was necessary to repeat the operation. Permanent work was determined upon. A boat was built for the Bas Obispo River and the first work done was the blowing out of the whole mouth of the stream to increase the rapidity of its flow into the Chagres. As the boatmen proceeded up the stream removing all vegetation from its bed, gangs of laborers upon each bank brushed out away the grass and removed all obstructions from the stream itself. As the shallows were reached these were treated in two ways. With a gravel or dirt bed the channel was deepened and narrowed and its banks confined by rough stone work. Where there were cascades or falls over the solid rock, dynamite was used to blow out a passage sufficiently wide and deep to completely do away with the permanent pools of water above. This work resulted in the obliteration of most of the standing pools and in the production of a constant effective current in those too large and deep for the constriction of their banks.

*Extract from report of Department of Health, Isthmian Canal Commission, Month of May, 1907.

The other streams were treated in much the same way, operations only being varied to meet the peculiar conditions of each.

The canal cut proper has been and is a constant source of much trouble. The progress of each steam shovel leaves in its trail new and varied problems to be solved in the way of drainage. In many instances an outlet is impracticable and the water supply can only be ditched in one pool. Here oiling is more effective, but throughout the canal cut much work has been done in constricting pools by filling in, deepening the ditches and confining the water by rough stone walls and ditching the large side pools, thus turning all the water into the main ditch, where it forms a swift running stream most unfavorable to mosquito breeding. Drip barrels of oil were placed at points where the current slowed down, and this, combined with the rapidity of the current, has reduced the breeding in the canal cut to a minimum.

At no time during the month has the mosquito inspector failed, after a little painstaking work, to locate the "point of infection" in any district reporting an increase of malarial cases.

This is a point of great interest. The malarial reports of the district physicians being tabulated, the number of cases in the different camps is compared with that of the previous three weeks. If there is a decided increase of malaria at any camp, the inspector of that district is telephoned to look for the "point of infection." The mosquito inspector then takes the list and goes over the whole ground, in order of greatest increase, locating or confirming the "point of infection," and reports upon the measures best adapted for the removal of same. All the laborers of this district, that can be spared from the daily routine work, are at once concentrated at that point to make a swift and effective end to the mosquito breeding places. The effectiveness of this system is borne out by statistics, of which the following are good instances:

CASES OF MALARIA REPORTED SENT TO HOSPITAL FROM 40-MILE CAMP, PEDRO MIGUEL, CUCARACHA CAMP AT PARAISO, AND HAUTE OBISPO CAMP, AT BAS OBISPO.

	40-Mile Camp; av. pop'n, 723.	Cucaracha; av. pop'n, 402.	Haute Obispo; av. pop'n, 400.
March 1.....	5	7	7
March 9.....	14	13	6
March 16.....	20	14	15
March 23.....	14	18	11
March 31.....	13	5	10
April 6.....	4	8	12
April 13.....	5	6	2
April 20.....	8	4	4
April 27.....	4	4	3
May 4.....	5	6	0
May 11.....	5	11	3
May 18.....	3	3	2
May 25.....	1	1	2

It will be noticed that on March 1, 40-Mile Camp had only what might be called a "normal percentage" of malaria. On the week ending the 9th it jumped to 14; on that of the 16th, to 20. On the 10th the mosquito inspector located the point of infection in a large old French scow that had been completely hidden by the overgrown jungle. A few scattering breeding places were found at more distant points, but this was not over 200 yards from the camp. The larvae in the scow were destroyed and the immediate neighborhood brushed and all vegetation between it and the camp cut out. The houses within which adult anopheles were found were fumigated. For the week ending April 6, only four cases were reported, and the rate has continued "normal" every week since; while for the week ending May 25 only one case was reported from *all* the camps of Pedro Miguel District, and that was brought in from the jungle outside of our limit of action.

The point of infection at Haute Obispo was found due to the unusual conditions of the Bas Obispo River, heretofore mentioned. These three instances prove the rule, which is daily borne out by past and present experience, that the steady rise in malarial percentage at any point means the existence of a definite localized point of infection, which when once discovered and eradicated is invariably followed by a drop in the number of malarial cases. Furthermore, the malaria developed by a given point of infection loses its activity in from three to four weeks; that is, that a given body of men infected with malaria at a given point develop fever from that infection within four weeks, and only incidentally afterward.

The health conditions would seem to be better than during the previous months of American occupancy. The largest malarial percentage for any week has been 0.65%, while it has been down as low as 0.52%. The percentage for all diseases has run from 0.98% to 1.01%. This seems not only due to favorable climatic conditions, but largely to the improved housing and feeding of the employees.

WATER SUPPLY IMPROVEMENTS at Lynchburg, Va., are recommended by the Committee on Fire Prevention of the National Board of Fire Underwriters (135 William St., New York). These include a reservoir with a holding capacity of at least a week's supply, half a dozen 12-in. mains and some smaller pipes, and improvements in the gate and hydrant system.

THE FAILURE OF A REINFORCED-CONCRETE BUILDING AT PHILADELPHIA.

The three-story and basement reinforced-concrete building in course of construction for Bridgman Bros. Co., manufacturers of steam-fitters' supplies, at 15th St. and Washington Ave., Philadelphia, collapsed on July 9, killing two of the workmen and injuring, more or less seriously, about thirty others. The building, which is to be used as an annex to the present plant, is built of reinforced-concrete columns, girders and floor slabs, with brick face walls. Although it adjoins existing brick buildings on each side, the side walls are of entirely independent construction.

The design, shown in Figs. 2-3, was made by Milligan and Webber, a firm of Philadelphia architects, with the advice of Mr. Amos W. Barnes, consulting engineer, and was fully approved by the Bureau of Building Inspection of the city. Some trouble had been experienced with the foundations in underpinning the walls of the adjoining buildings, but the footings as finished were fully capable of bearing the load upon them. Floors were designed for loads of 180 lbs. per sq. ft. on the first floor and 120 lbs. per sq. ft. on the second and third floors, with 30 lbs. per sq. ft. on the roof. The reinforcement is of straight round rods. The columns are reinforced in the four corners by vertical rounds tied together with wire for ease in manipulation, but not to give additional strength by hooping. Very heavy reinforcement was placed in the beams and girders. In addition to the usual horizontal straight rods, shear stirrups, made of ordinary rounds bent in U-shape and varying in size with the depth of the girder, were placed near each beam and girder end. The exact size and position of these stirrups are not at all well shown on any of the available drawings, and an inspection of the destroyed portion failed to discover their presence in several of the beams and girders, as provided for in the design. With the exception of these omissions, which are not at all conclusive, owing to the shattered nature of the debris, the design of reinforcement has been well adhered to. In order to provide resistance to continuous beam action over supports, every other tension rod was raised from the lower edge of the beam to the upper at each column and carried through the column in this position, wire ties connecting beam and column reinforcement. Floor slabs were reinforced with 3-in. wire mesh.

The concrete used was hand mixed, and extremely high in cement, consisting of one part cement, one part sand and two parts stone. The cement was of standard brand, but as far as can be ascertained not subjected to any but the regular mill tests; the sand was of good grade and quality; the stone for the first two stories of the building was a crushed trap or bluestone, and for the third story and roof a clean, hard gravel. Where proper time had been allowed it to set, the concrete was hard and compact, fully equal to any load to which it could have been legitimately subjected.

At the time of the accident, the first three floors had all been completed and the forms removed, the newest concrete in these lower floors being about a month old. All of the columns supporting the roof were finished and on the north half of the building (where collapse occurred) the roof girders and slabs had been in place 5½ days. Form work was going on at the time upon the girders and slabs of the southern slope of the roof. The girder spans of 17 ft. were supported by seven struts spaced about 2 ft. c. to c. According to the regulations of the city of Philadelphia, these struts should have been allowed to remain in place two weeks from the time of depositing the concrete. However, on the day of the collapse, the sub-foreman in charge of concreting ordered a negro laborer to remove every other strut from under each of the roof girders, thus leaving the girder to be supported by three or by four struts, according as the laborer understood the order. The sub-foreman did not remain to see this work started, but left for another job which his company was building. The negro transmitted the order in turn to some Italian laborers who, from ignorance of the language, misunderstood and proceeded to knock out every strut under girders holding concrete which had been deposited but 5½ days previous.

It is not known just how far this action proceeded, but beginning at the back of the building, where the removal work probably started, the whole existing roof structure gave way and, pulling with it the girders and columns, broke through each floor in succession. The most northerly bay of the first floor was broken and the whole mass of debris carried through to the basement. The bay directly south of this, on the first floor, held under the heavy impact of the falling mass and although the girders and beams were badly cracked, the floor system did not give way.

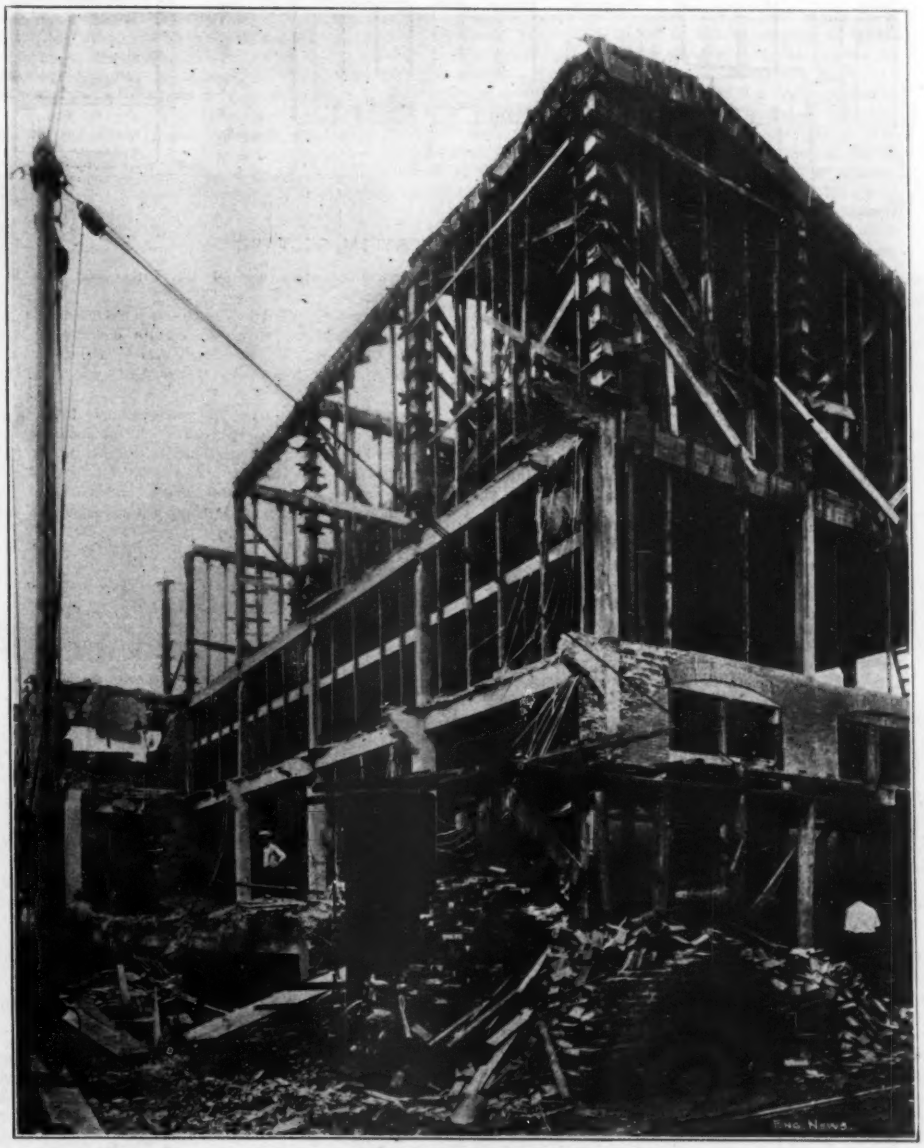

FIG. 1. VIEW OF COLLAPSED PORTION OF REINFORCED CONCRETE BUILDING AT PHILADELPHIA.

Fig. 1 shows a view of the collapsed portion of the building. The concrete on the second floor, which had been in place well over a month, is very solid and hard, and the girders at this point failed in direct vertical cracks, stripping the concrete from the encased rods. The connections at the columns between reinforcement must have been very firm to permit of failure in this manner. The floor slabs broke clean at the girder edge, each piece of wire mesh being broken off there and not pulled out from the remaining slab. The under side of that portion of the first floor which held up under the falling upper stories is shown in Fig. 4. The view was taken directly under the man who is standing on the first floor in Fig. 1. The effect of the impact is illustrated by the very well-defined shear cracks in the transverse girder and the longitudinal girder at the extreme right. Every one of these lower girders shows these typical shear cracks and in several instances the lower 2-in. covering of concrete is stripped from the rods. The columns do not seem to be affected.

An examination of the concrete in the structure shows that the material in the lower part of the building, which had been in from one to two months, was hard and solid and of as good structure and strength as the best. The material taken from the upper part of the work, which had not had sufficient time to set, was of a more fragile nature, somewhat crumbly and easily broken, showing that the set of the concrete had not advanced to a strength sufficient for the removal of supporting forms. Owing to the very low pressure in the water mains at this low-lying part of Philadelphia, it was difficult to get water up to the roof of the building to wet down the concrete in setting, and so this very important operation was omitted altogether in the upper stories. A careful investigation is now being made by the building department of the city and also by experts for the coroner's inquest, but unless some new developments arise which can in no way be found at the present time, the accident seems to have been due entirely to the premature removal of supporting struts from under the roof girders. Considering the state of the concrete in the upper part of the building, it is certain that the safety of the structure would have been seriously endangered by the removal of even every other strut, as ordered by the sub-foreman. The removal of

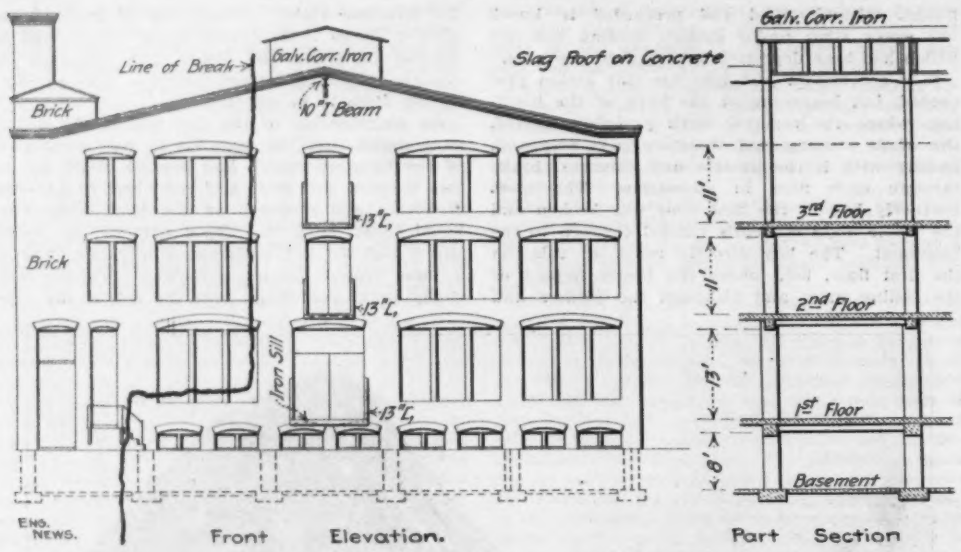

FIG. 2. ELEVATION AND VERTICAL SECTION.

every strut from forms containing little better than a hard mud was certain to cause collapse.

The sub-foreman who ordered the removal of the struts has been held by the coroner for $3,000 bail, charged with criminal negligence. The coroner's jury has not yet reported on the case.

THE EXPLOSION OF A POWDER CHARGE in the after superimposed turret of the battleship "Georgia," on July 15, killed nine officers and men and injured twelve others. Two more of those injured were not expected to live at the latest report.

The "Georgia" was engaged in target practice off Cape Cod with other vessels of the North Atlantic Squadron; the crew in the turret where the accident occurred had just sent an 8-in. shell through the target, and were about to reload for another shot—the shell having already been placed in the breech and the two bags of smokeless powder being in the arms of the loader ready for insertion—when one of the bags was seen to be smoldering.

The charge exploded before the men in the turret could protect themselves, with the results described. Lieut. C. F. Goodrich, son of Rear-Admiral Goodrich, Commandant of the New York Navy Yard, was one of the killed.

Rear-Admiral Thomas has ordered an investigating board to examine into the cause of the accident; until the board reports the actual cause will be in doubt. A spark floating into the turret and alighting on the powder bag seems the most probable cause; but whether it was from one of the funnels, and entered through the ventilator, or from one of the after-turret guns, and floated back and entered through a gun port, is in doubt.

Similar accidents on other ships of the navy—the worst being that on the "Missouri" off Pensacola, Fla., in April, 1904, in which 23 men met death—have led to careful study and the adoption and application of automatic safety devices calculated to safeguard absolutely the crews of the turrets. The report of the investigating board will be interesting in the light of these earlier precautionary measures.

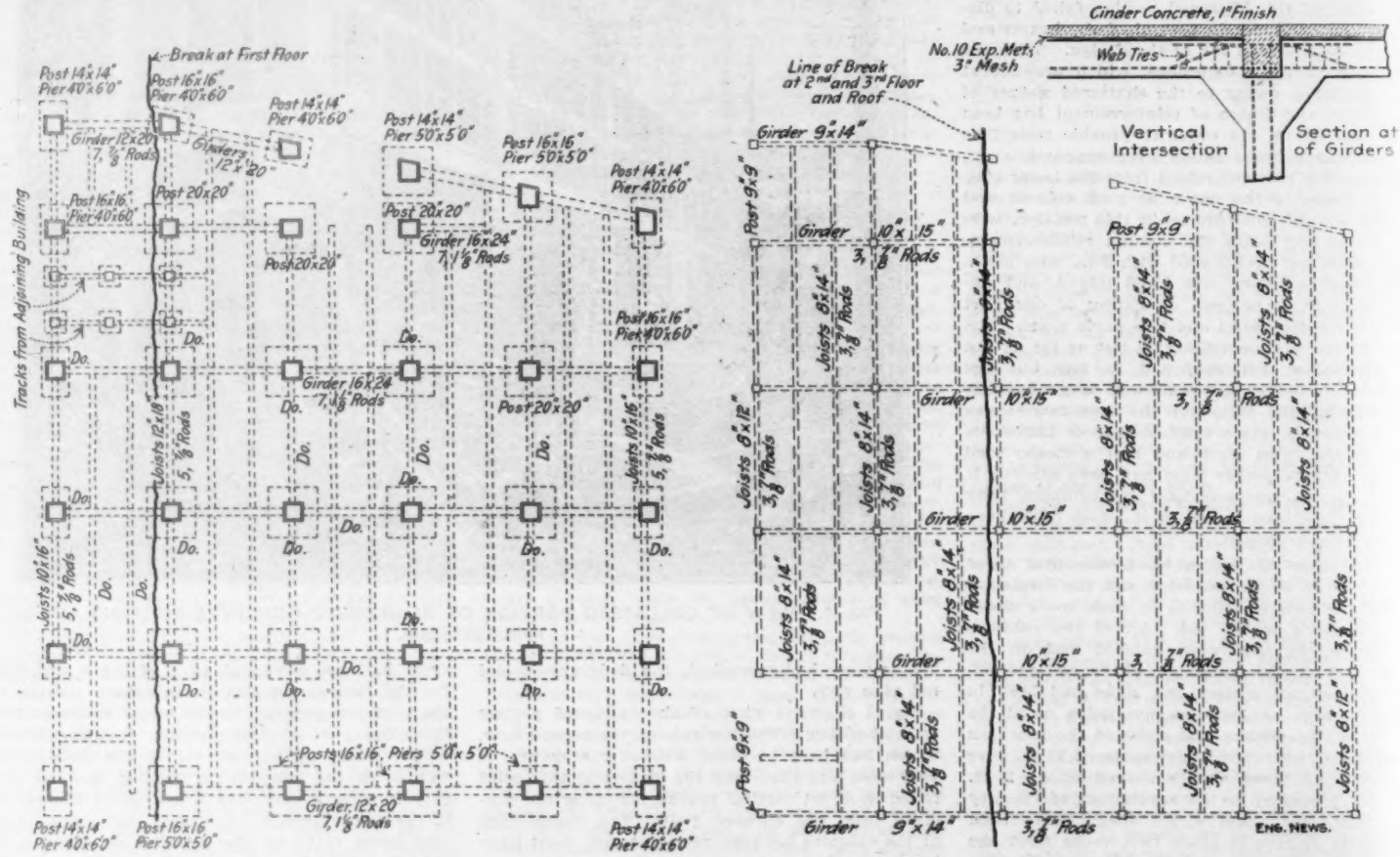

FIG. 3. FLOOR PLANS.

A FOUR-STORY BRICK BUILDING COLLAPSED at Cincinnati, Ohio, on July 2. The cause of the collapse was excavation in progress on the adjoining lot, where a 14-story office building was to be erected. The building which fell gave evidence of its dangerous condition for some hours before the failure occurred; and had been in such bad condition previously that on April 16 the City Building Department notified the owners that its bracing and shoring must be attended to or the building would be ordered vacated. Laborers were at work in the cellar of the building endeavoring to place shores when the collapse occurred and 15 of them received injuries.

SIX PERSONS were killed and 20 injured on July 14, in a wreck on the Southern Ry., near Johnson City, Tenn. A through passenger train ran into a light switch engine, and, although the latter was not damaged and ran away "wild" after the collision, the passenger engine, a baggage car, a mail car and a second-class coach were overturned. The mail car, of heavy steel construction, was not crushed, but the wooden coaches behind it were telescoped. Error in making out orders by a telegraph operator is said to have been the cause.

A FREIGHT LOCOMOTIVE drawing a Grand Trunk Ry. train blew up on July 9, while drawing a heavy train on the Central Vermont Ry., near St. Alexander, P. Q. While the engine was completely demolished, the car next the engine also, and the track and roadbed badly torn up, neither the engineer nor fireman was killed, nor was the conductor, who was on the engine at the time.

"TRACKS BUCKLING UNDER THE DINING CAR" is the reported official statement given out by the Southern Ry. as to the cause of a wreck on that line at Jamestown, N. C., near Greensboro, on July 15. Eleven persons, mostly employees, were injured. The train, a northbound passenger, was running about 35 miles an hour when the diner, a Pullman coach and a day coach were derailed.

A RAILROAD BRIDGE COLLAPSED and fell into the small stream which it spanned, five minutes after a passenger train from Indianapolis on the Michigan Division of the Big Four R. R. had passed over it on July 8.

A TORNADO WROUGHT HAVOC in the towns of Oakdale and Berlin, Wis., on the night before July 4. Every building in Oakdale was reported as blown down or damaged.

A CLOUDBURST AT GOLDEN, COLO., on July 10 carried away several miles of track and bridges on the Colorado & Southern Ry., and did considerable damage in the town itself.

SEVEN MINERS WERE SUFFOCATED by "white damp," or carbon monoxide, on July 11 in an abandoned working of the Lehigh & Wilkes-Barre Coal Co. at Honeybrook, Pa. Two of the men had been sent in to measure the water; then two more went in to assist them; later, in the belief that the force was inadequate, three more were ordered in. When the men did not return a rescuing party went in and discovered the presence of the "white damp"; the rescuers themselves were overcome after recovering but one body.

"White damp" is the most treacherous and difficult to detect of all mine gases; it cannot be detected with a safety lamp, which burns brightly in it. It is a narcotic poison of rapid effect; 1½% of it in atmospheric air will cause death. It results from mine fires and imperfect combustion and is found where heavy blasts have been set off and subsequent ventilation has been inadequate.

A ventilating fan to clear the workings was installed after the accident.

THE BURSTING OF A 20-IN. WATER MAIN in the Borough Hall district of Brooklyn, New York City, early in the morning of July 11 caused considerable damage to property and an interruption of telephone and traction service. According to press reports the cap at the head of a main blew off, causing an artificial geyser, whose discharge flooded the nearby street for nearly an hour before the nearest gate on this main could be shut off. Traffic was suspended for some three hours in the rush period of the morning. There was apprehension that the subway construction at that point might be damaged by the flood, but the walls withstood the pressure and remained impervious.

THE HYDRAULIC LIFT LOCK ON THE TRENT Valley Canal, at Kirkfield, Ont., was formally opened on July 6, and for the first time steamers crossed the elevated land in central Ontario and entered Lake Simcoe. The lock is described on another page of this issue. When 23 miles of waterway improvement and additional canal have been completed at the Lake Ontario end, from the vicinity of Peterborough to the lake, and 14 miles at the Georgian Bay end, it will mark the completion of a project begun by the British Government 70 years ago, and will provide an additional water route from Lake Huron to Lake Ontario, 250 miles shorter than that via Lakes St. Clair and Erie and the Welland Canal.

It will not have the depth of the Welland route, which is 14 ft.; the Trent Valley canal has but 7 ft.

The surveys for the Lake Ontario end have been completed, and Parliament has allotted $700,000 to cover the work of construction. At the Georgian Bay end the best route has not yet been decided upon. It is expected that the work will be completed in from four to five years.

RAIL JOINTS OF THE WEDGE TYPE have been frequently designed both in this country and abroad, but have never had more than experimental trials in service. The principle common to most of these is that the rail ends lie within a heavy bridge or clamp of channel section, and are secured by long taper wedges driven between each side of the rail and the side of the channel. A French rail joint of this type has been subjected to a number of tests at the testing laboratory of the Conservatoire National des Arts et Metiers, at Paris, France, and has shown ample strength as against deflection or breakage. A few of the joints have also been tried in the tracks of the Paris street railways and after 16 months' service were reported as having given satisfactory results. The clamps are heavily ribbed steel castings. Each wedge is of such shape as to bear against the side and under the overhanging rib of the clamp, and also against the web and top and side of base of the rail. Cotters driven vertically in grooves in the faces of the clamp and wedge prevent the latter from working loose. The elimination of bolts and the maintenance of a permanently tight joint are the principal advantages claimed for joints of this type.

FIG. 4. UNDERSIDE OF FLOOR WHICH STOOD UP UNDER FALLING LOAD OF THREE UPPER STORIES.

Note shear cracks in girders.

THE ROUTE OF THE CATSKILL AQUEDUCT will probably be changed at the upper end by the Board of Water Supply of New York City. The change will affect the whole section from the Ashokan Reservoir to and beneath the Hudson River. The new location will head further toward the west end of the reservoir, near the site of the proposed Olive Bridge Dam. From this point the aqueduct will extend in a general southerly direction, a considerable number of miles to the westward of the original location, striking the Hudson River at or just above Storm King Mountain. It should be remembered that the route first laid down (October, 1905) was tentative, having been chosen only a few months after the appointment of the Board of Water Supply. This speedy choice of a route was necessary in order to comply with legislation requiring the Board to file plans with the State Water Supply Commission and secure the approval of that body before proceeding with its water supply development. The detailed studies that have been made since the original plans were filed show that there is no suitable rock for a high-pressure waterworks tunnel beneath the Hudson River at the crossing point first proposed, which is many miles above the site now under consideration. Borings up and down the river, some of which are still in progress, indicate the probability of suitable rock at Storm King Mountain. Shafts are being sunk, one on either side of the river, some 3,000 ft. apart, and from these shafts horizontal test borings will be made to determine the character of the rock at the proposed new crossing. The depth of these horizontal borings will of course depend upon the character of the material encountered in the shafts, but it is assumed that they will be some 600 ft. below the water surface. If suitable rock is not found, it is likely that steel pipe will be laid on the bed of the river, or that some other form of conduit will be laid on or not far below the river bed, a short distance above the site where explorations are being made for a tunnel. Such a river bed crossing would be considerably longer than the tunnel which it is hoped it will be possible to build. It is interesting to note in passing that the surface of the Hudson River is some 400 ft. below the hydraulic gradient of the Catskill Aqueduct at the point of crossing. The proposed new location will make no material difference in the length of the aqueduct, and it will shorten by some 12 miles the Rondout Aqueduct, which is to discharge into the main aqueduct. It is thought that the new location would prove to be more favorable in the matter of stream crossings and other respects than the old one, and it is also believed that the more westerly inlet to the aqueduct would be an improvement. In accordance with legislative requirements the proposed change in route must be approved by both the Board of Estimate and Apportionment of New York City and the State Water Supply Commission, and a public hearing must be held by each. The first-named body has held the required hearing (July 8), and at the hearing no objectors appeared. It has approved the proposed change. Mr. J. Waldo Smith, M. Am. Soc. C. E., is Chief Engineer of the Board of Water Supply; Mr. Alfred D. Flinn, M. Am. Soc. C. E., is Engineer of Headquarters Department; Mr. J. Edward Simmons is President of the Board, which has offices at 299 Broadway, New York City.

WORK ON THE TOPOGRAPHIC MAP of the United States will be prosecuted by the U. S. Geological Survey during the present year in 35 different states and territories. In twelve of the states and territories the respective states are cooperating with the National Government. As many of our readers know, the topographical survey of Massachusetts, Rhode Island, Connecticut and New Jersey was completed and the results published some time ago. Details of the work in progress, with the names of the topographers in charge, are given in a bulletin recently issued by the U. S. Geological Survey, Washington, D. C. From the same source information may be secured regarding the topographic atlases and the separate sheets thus far published. The sheets may be obtained for 5 cts. each, or $3 per 100.

A SUBWAY SCHEME FOR CHICAGO is projected by the Chicago Subway Arcade & Traction Co., which proposes to revive an old scheme. Mr. Wm. P. Nixon is president of the new company. The directors include Mr. John M. Ewen and Mr. Samuel M. Rowe, Mems. Am. Soc. C. E., and Mr. Dwight H. Perkins, Architect.

PERSONALS.

Mr. Wm. McNab, Assistant Engineer with the Grand Trunk Ry., has been appointed Principal Assistant Engineer.

Mr. James Birmingham, for many years President of the Board of Water Commissioners of Hartford, Conn., has resigned.

Mr. Horace Moses, M. Am. Inst. M. E., of Silver City, N. M., has been appointed Superintendent of the property of the New England Copper Co., at Clifton, Ariz.

Mr. Wm. Wainwright, formerly General Assistant and Controller of the Grand Trunk Ry., has been elected Fourth Vice-President. The former position has been abolished.

Mr. J. A. Simmons has resigned as Division Engineer of the St. Louis, Iron Mountain & Southern Ry. at Ferriday, La. Mr. J. A. Wright, Roadmaster of the Valley Division, succeeds him.

Mr. A. D. Hatfield, Secretary and Treasurer of the Wellman-Seaver-Morgan Co. of Cleveland, has resigned. Mr. W. H. Cowell, formerly of the Algoma Steel Co., Sault Ste. Marie, Ont., succeeds him.

Mr. Fred. E. Foss, M. Am. Soc. C. E., has resigned as Professor of Civil Engineering at the Pennsylvania State College to accept a similar position in the School of Applied Science of the Carnegie Technical Schools.

Mr. P. Laden, Assistant to the Assistant Chief Engineer of the Illinois Central Ry., has been appointed Superintendent of the Peoria Division, with offices at Mattoon, Ill. His former position has been abolished.

Mr. Wm. D. Batchelor, of Nutley, N. J., who for the past 15 years has been Chief Engineer of the Structural Department of Milliken Bros., Inc., has resigned his position.

Mr. Bird Robinson, President of the Mobile, Jackson & Kansas City R. R. and the Gulf & Chicago Ry., has resigned. Mr. L. S. Berg, former President of the New Orleans Terminal Co., has been elected to fill the vacancy.

Mr. H. R. Safford, Assistant Chief Engineer of the Illinois Central and the Yazoo & Mississippi Valley Railroads, has been appointed Chief Engineer of Maintenance of Way of both roads with headquarters at Chicago.

Mr. D. D. Curran, formerly Vice-President, has been elected President of the Cincinnati, New Orleans & Texas Pacific Ry., to succeed Mr. C. C. Harvey. Mr. L. A. Jones has been promoted from the auditorship to succeed him as Vice-President.

Mr. J. F. Peters, Division Engineer of the Missouri Pacific Ry. at Little Rock, has been appointed Principal Assistant Engineer with offices at St. Louis. He is succeeded at Little Rock by Mr. P. Carroll, heretofore Division Engineer at De Soto, Mo.

Mr. W. F. Graves, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer in charge of construction on the lines of the South Side Elevated Ry., Chicago, has been appointed Division Engineer of the Chicago City Ry. Co. in charge of track rehabilitation.

Mr. E. C. Hawkins, Chief Engineer of the Oregon & Washington Ry., now under construction, has resigned to take charge of railway construction in Alaska, with the Guggenheim and Morgan interests. Mr. H. F. Baldwin, formerly Chief Engineer of the Chicago & Alton Ry., has been appointed to the vacated position, with offices at Seattle.

Mr. W. E. Baldry, who for the past two years has been in charge of second track construction for the Atchison, Topeka & Santa Fe Ry., with headquarters at Chillicothe, Ill., has resigned to go to Chena, Alaska, as civil and mining engineer for the gold claims of his brother in that district. Mr. L. A. Ames succeeds him in the position which he leaves in Illinois.

Prof. Arthur A. Noyes, of the Department of Theoretical Chemistry at the Massachusetts Institute of Technology, and Director of the Research Laboratory of Physical Chemistry there, has been appointed by the executive committee to act as President of the Institute until the vacancy left by the resignation of former President Henry S. Pritchett is permanently filled.

Mr. Wm. Darbee, who for nearly a year has been Manager of the Albany & Hudson R. R., has resigned to become Assistant Manager of the Consolidated Gas, Electric Light & Power Co., of Baltimore. His resignation from the railroad service will take effect Sept. 1; Mr. Raymond H. Smith, now Superintendent of the Bridgeport Division of the Connecticut Ry., will succeed him.

Mr. H. Milliken, who recently joined the engineering staff of W. S. Barstow & Co., 50 Pine St., New York City, has gone to the Portland, Oregon, office of the firm, where he will be permanently located as Resident Electrical Engineer. Mr. Milliken is a graduate of the Massachusetts Institute of Technology. For the last two years he has been identified with the operating department of the New York Edison Co.

Mr. Ira A. McCormack, heretofore Assistant to General Manager and Vice-President A. H. Smith, of the New York Central & Hudson River R. R., has resigned his position. He has been elected President and General Manager of the Randolph & Cumberland R. R., running at present from Cameron, S. C., to Hillsons, and also President of a development company to operate in the territory of the railroad.

Mr. Wm. J. Wilgus, M. Am. Soc. C. E., Vice-President of the New York Central & Hudson River R. R., in charge of construction, has tendered his resignation, to take effect on Oct. 1. Mr. Wilgus has several times during the past two years suggested his desire to retire from his official connection with the service of the company, but the great work of changing from steam to electric power in the Electric Zone and the reconstruction of the Grand Central Terminals have made it almost impossible for the road to comply with his wishes. The initial installation of electricity having been completed, and the practicability and success of handling the business of the road by the new power having been fully demonstrated by some months of successful operation, he renewed his request to be relieved at as early a date as practicable, suggesting July 1st as the date. At the request of President Newman, however, he has consented to remain in his present position until Oct. 1.

The Interstate Commerce Commission has appointed a board of experts to supervise and conduct experimental tests of block signal systems and other safety devices as provided for by the joint resolution of Congress. The members of this board are Prof. Mortimer E. Cooley, Captain Azel Ames, Jr., Frank G. Ewald and B. B. Adams.

Professor Cooley, who has been named as chairman of the board, graduated from the United States Naval Academy in 1878, but resigned from the service in 1885 to accept the chair of Mechanical Engineering in the University of Michigan, which position he has held since that date, for the last three years being Dean of the Department of Engineering at the University. He has performed valuable service for the State of Michigan in making a physical valuation of steam railroad property in that state for taxation purposes. In 1902 he went to Newfoundland to assist the Government in making an appraisement of the mechanical equipment of the railroads. He also acted as counsel in the beginning of the work of physical valuation of the railroads in the State of Wisconsin. In 1903 he had charge of the work of appraising the Michigan railroads, in connection with a suit brought by the railroads to enjoin the Auditor from collecting taxes which had been assessed by the State Board of Assessors, and in 1906 he reappraised the railroads of Michigan for taxation purposes in connection with the assessment made by the State Board of Assessors. He has been employed by the State of Michigan at various times during the past 15 years in a consulting capacity in connection with state institutions. In 1906 he was employed by the city of Chicago as one of the commission to value the street railways of Chicago in connection with the campaign for municipal ownership of those properties. He was also employed by the city of Detroit to make a physical valuation of the street railways, electric light and telephone properties for taxation purposes.

Captain Ames, who is named as the second member of the board, is a graduate of the Massachusetts Institute of Technology and has had several years' experience with railway work in the maintenance of way department. He was an officer in the Corps of Engineers of the U. S. Army during the Spanish-American war, and subsequently had several years' experience in signal work as Signal Engineer of the Lake Shore & Michigan Southern Ry. He is at present Engineer in direct charge of the signaling in the electric zone of the New York Central & Hudson River R. R., New York City—probably the most difficult and involved installation of block and interlocking work ever undertaken in the world.

Mr. Frank G. Ewald, the third member of the board, has been Consulting Engineer of the Railroad and Warehouse Commission of the State of Illinois for the past ten years, prior to which he was employed by the city of Chicago in charge of tunnel work for the water system of that city. Before his connection with the city of Chicago, he was employed in the engineering department of the Atchison, Topeka & Santa Fe Ry., in charge of construction work in the State of Illinois. Most of his time since his connection with the Railroad and Warehouse Commission has been spent in the inspection of block signal systems, and a large number of new systems have been installed and many of the old systems rebuilt largely through his recommendations.

Mr. B. B. Adams, the fourth member of the board, has for twenty years been one of the editors of the "Railroad Gazette," and is a recognized authority on signaling. He has had long experience in railroad work in America, and is the author of a standard work on block signaling. He was for two years secretary of the Railway Signal Association. He has had charge of the preparation of the accident bulletins of the Commission for the past five years, and performed the technical work in connection with the report on block signaling which the Commission made to Congress last winter.

Mr. W. P. Borland, who has been designated by the Commission as Secretary of the Board, has been employed by the Commission for the past five years in charge of safety appliance work. He has had extensive practical experience in all branches of train service and is thoroughly familiar with block signal work and safety appliances.

In the appointment of this board of experts, the Commission has had the cooperation of the American Railway Association. A sub-committee of that Association came to Washington and conferred with the Commission with reference to the proposed tests and the composition of the board of experts. This sub-committee was composed of Mr. F. C. Rice, General Inspector of Transportation of the Chicago, Burlington & Quincy Ry.; A. M. Schoyer, General Superintendent of the Northwest System, Pennsylvania Lines west of Pittsburg; W. G. Besler, Vice-President and General Manager of the Central R. R. of New Jersey; A. T. Dice, General Superintendent of the Philadelphia & Reading Ry.; E. C. Carter, Chief Engineer of the Chicago & Northwestern Ry., and D. C. Moon, Assistant General Manager of the Lake Shore & Michigan Southern Ry. The Committee has tendered the Commission the use of railway tracks and other facilities for conducting the tests, and will cooperate to the fullest extent in securing the best results.

The Board will maintain an office in Washington at the headquarters of the Interstate Commerce Commission, and will hold meetings as often as may be necessary to conduct its work. The first meeting was held on July 14, at which a plan of work was outlined. The Board will call upon those who have devices or systems to be tested to furnish information concerning them.

Obituary.

Charles H. Nye, who for years was Superintendent of the Cape Cod division of the Old Colony R. R. before that road was leased by the New York, New Haven & Hartford R. R., died on July 9 at the age of —, at his home in Hyannis, Mass.

Arthur C. Lloyd, President of the Michigan Contracting Co., of Detroit, died on July 12 of tuberculosis. He was 38 years old. The electric road between Jackson and Battle Creek was partly built by him, and he has had large paving contracts in the city of Detroit.

William Henry Colesberry, a veteran railway engineer, died in Philadelphia on July 12 at the age of 66. He entered the service of the Pennsylvania R. R. in 1863, with an engineer corps in the construction of the connecting railway under the late A. J. Cassatt. Later he aided in the survey and construction of the Philadelphia & Erie R. R. For a time he was employed with other roads, but in 1876 he rejoined the Pennsylvania engineering forces and has been so associated ever since that time.

John Patrick Kane, President, Treasurer and a Director of the John P. Kane Co., manufacturers of building material and Portland cement, died on July 9 at Huntington, L. I. He was born in Canaan, N. H., in 1849, coming to New York when but 16 years old and entering the employ of Wm. J. & J. S. Peck, dealers in building materials. He started a business independently, along the same lines, in 1879. He was a member of the N. Y. Athletic, Manhattan, Democratic, Liederkranz, and Larchmont Yacht clubs.

Sir William Perkin, famous as the discoverer of aniline colors, and one of the world's most prominent chemists, died in London on July 14 at the age of 69. By a chance discovery in 1856, while working as an assistant to the German Chemist Hofman (formerly an assistant to Baron Von Liebig) he detached from "aniline"—so named by Hofman himself in the forties when he proved its identity with the product of the indigo plant—a vivid violet which was at first known as "Perkin's purple." The industries built upon that discovery now represent in this country an investment of $100,000,000; in Germany alone they give employment to 120,000 men. About 700 different shades are now produced by the process which he introduced. Johns Hopkins University conferred upon him the degree of LL.D. Last year he was invited to America by a committee of prominent industrial men and signally honored during his visit.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23-29. Annual convention at Toronto, Ont. Secy., R. W. Raymond, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
July 29. Annual convention at Seattle, Wash. Secy., Edw. A. Moseley, Interstate Commerce Commission, Washington, D. C.

ILLUMINATING ENGINEERING SOCIETY.
July 30-31. First annual meeting at Boston. Secy., Dr. A. H. Elliott, 4 Irving Place, New York.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 7-9. Annual meeting at Norfolk, Va. Secy., Frank P. Foster, Corning, N. Y.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, Oswego, N. Y.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. 38th Annual Convention at St. Paul, Minn. Secy., A. P. Dane, Boston & Me. R. R., Boston, Mass.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—At the 38th Annual Convention to be held at St. Paul, Sept. 10-13, the following subjects will be discussed: "The Painting of Steel Passenger Equipment—(a) How Should the Interior be Treated? (b) How Should the Exterior be Treated," J. D. Wright (B. & D.), H. M. Butts (N. Y. C. & H. R.), and R. J. Kelley (L. I. R. R.). "Plainness, Problems, Perplexities and Prophecies Pertaining to the Present-Day Railway Shop," C. E. Copp, (Bost. & Me.). "Disinfecting Passenger Cars at Terminals," H. E. Smith (Chem., L. S. & M. S.), R. W. Mahon (Chem., N. Y. C. & H. R.), A. J. Bunning (L. & N.). "The Cleaning, Coloring and Lacquering of Metal Trimming, Lamps, etc., for Passenger Equipment," R. E. Miller (D. L. & W.), Geo. Warlick (C., R. I. & P.), C. A. Cook (Phil., Balto. & Wash.) "Painting Locomotives and Tenders—(a) What Parts Should be Varnished? (b) What Parts Can be Treated with Enamels to Advantage? (c) Is It Advisable to Use Asphaltum or Oil Paints? J. H. Kahler (Erie), W. A. Buchanan (D. L. & W.), Engine Daly (Big Four). "To What Extent May the Various Linseed Oil Substitutes and Drying Oils Be Used in the Painting of Cars and Locomotives?" W. A. Quest (P. & L. E.), W. H. Smith (Southern).

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, July 18, 1907.

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EDITORIAL.

Government Publications and How They May Be Obtained.

Few people realize that the United States Government has at Washington in the Government Printing Office one of the largest printing and publishing establishments in the world. Still less is it generally known that it is constantly bringing out valuable scientific works compiled by experts and specialists in every department of science, in the direct employ of the Government and out of it. The law provides that all of these publications be obtainable by any one free or at the actual cost of printing and binding, if they are not out of print. The only difficulty is to know to whom to apply for information concerning these works.

Prior to 1892, the system was in great confusion and it seems to have been possible to obtain any book direct from the department publishing it, simply on request. By the general printing act of that year, however, the office of the Superintendent of Documents was created in connection with the Government Printing Office and during the fifteen years since that time the distribution of Government documents has become very much more systematized. The present superintendent is Mr. William L. Post, who has held the position since February, 1906.

This office has become the repository for an exceedingly valuable collection of Government publications, dating back to the early days of the Republic. The total number of volumes under its care now numbers several millions, of which about 700,000 are assorted, forming the sales stock, and covering nearly every important department, bureau and series. Many rare books are included, but under the law all must be sold "at cost," regardless of their age and scarcity. Of many of the most valuable works only one or two copies remain. To handle this immense mass, several document experts in reference work are employed.

It is the policy of the office to facilitate as far as possible the distribution of the publications prepared at great expense by the Government. For this reason, the Superintendent of Documents will upon request gladly furnish any information regarding public documents, as to how and where they may be obtained and, if they are on sale, at what price. In answering such inquiries great care is taken and no labor is spared in supplying full and accurate information.

The office is intended as a great clearing house for Government publications. It carries on an enormous exchange business with libraries and educational institutions and in this way does something towards remedying the absurd and illogical distribution of public documents now sanctioned by law. Through this method of exchange, hundreds of libraries have been supplied with publications greatly needed in their respective localities in exchange for those which are either duplicates or of no service to them.

There are a few very simple restrictions in the purchase of documents. The office supplies no documents free of charge nor can they be forwarded in advance of payment. Money must be sent by postal money order, express order, or New York draft; stamps and uncertified checks are not received.

As has been said, the Superintendent of Documents can supply information regarding all Government documents, and can furnish all such as are in his care. Some, however, are distributed direct by the departments, and in such cases, with some exceptions, can be obtained free. Each department issues gratis a price list of its publications, which can be obtained upon application.

To particularize: The Geological Survey probably publishes more matter of interest to the engineering world than any other department of the Government. Most of its larger publications, such as the annual reports, monographs, water supply and irrigation papers, reports on mineral resources, etc., are distributed through the office of the Superintendent of Documents. All the publications of the Survey, except monographs, atlases and atlas sheets may be obtained free of cost by writing to the Director of the Geological Survey. The free publications include the useful series known as water supply and irrigation papers. The geologic folios, of which many have been prepared, embracing sections from many states of the Union, are on sale by the Director of the Survey, at prices ranging from the standard price of 25 cts. up to $11 each, with discounts on large orders. In the same way, the topographical sheets which are prepared in connection with the folios, and as a basis for them, are sold at the rate of 5 cts. each, or $3 per 100 sheets.

All publications of the Department of Agriculture and of the Smithsonian Institute are supplied through the Superintendent of Documents; the Weather Bureau and American Republics Bureau sell their own publications. Those of the Navy Department, Department of Commerce and Labor and the Civil Service Commission are supplied free on application.

No general catalogue of U. S. Public Documents exists, but the Superintendent of Documents has within the last few years issued a monthly catalogue of documents published during each month, both those under its own charge and those distributed by the separate departments. This can be obtained at the annual subscription price of $1.10, and is of great assistance in keeping up with Government publications. Separate price lists on special subjects are being prepared from time to time and are free.

It is frequently possible, also, for one to obtain documents, especially current Congressional documents, free upon application to his Senator or Congressman, as the law allots to each a certain number of copies of each document at it appears.

In so far as it is practicable, it is the aim of the editor to list in this supplement all government publications of interest to engineers, and to comment on the more important papers and reports.

REVIEWS.

Walls, Bins and Grain Elevators.

Reviewed by EDWARD GODFREY.*

THE DESIGN OF WALLS, BINS AND GRAIN ELEVATORS.—By Milo S. Ketchum, C. E., Dean of the College of Engineering and Professor of Civil Engineering, University of Colorado; Consulting Engineer. New York: The Engineering News Publishing Co. London, England: Archibald Constable & Co. Cloth; 6 × 9 ins.; pp. 393; 240 illustrations, mostly in the text, and numerous tables. $4, net.

Professor Ketchum's latest work is divided into three parts, treating of the three branches indicated by the title. The first part is a presentation of the theory, or the theories, of retaining walls. This is followed by a chapter on the design of masonry retaining walls and then a chapter on reinforced concrete retaining walls. The next chapter is on experimental data. Next there are given numerous examples of actual retaining walls and then data on the cost of such walls. The second part takes up the subject of coal bins, ore bins, etc., giving theory, principles of design, cost and actual examples. This part has a chapter on methods of handling materials, describing conveyors, etc. Part three is on the design of grain bins and elevators. As in the other parts, there are chapters on experimental data, theory, construction in various materials, examples and cost. Added to the above are definitions and specifications for masonry and specifications for steel work recommended by the American Railway Engineering & Maintenance of Way Association.

The book is of especial value because of its many examples of structures. The illustrations of existing plants show not only the general lay-out of the plants by line drawings and photographs, but also give details of many parts, besides, in some instances, exhibits of the methods of construction. This sort of construction has been largely in the hands of companies who make a specialty of it, and the collection of data available in this book makes it a work of exceptional value to structural engineers. Anyone desiring to make a specialty of this line of work cannot afford to be without this book, and it will no doubt be a valuable assistant to any specialist, as showing the different ways of meeting different conditions.

The book is also of value because of the data regarding cost of structures. It is only in recent years that writers have dared to invade the privacy of the contractor and lay bare the secrets of the cost of material and work. A few years ago it was considered the special province of the few to hold the secrets of cost. Experience was counted to be absolutely essential before a man was fit to talk intelligently about cost. Book learning on such a subject was adjudged useless. But, thanks to some excellent books on the subject, all this is changing, and we may even expect that our learned judges will some day concede to a professional man, though he does not wear rubber boots or is not an executive officer in a manufacturing establishment, the right to judge of the cost of a structure based on the kinds and amounts of materials of which it is made. It seems to be the opinion, in some courts at least, that the cost of a structure is arrived at in some such way as a dog fancier fixes the value of a dog or as horse flesh is judged, and that the amount of material has

*Monongahela Bank Building, Pittsburg, Pa.

no more to do with it than the avoirdupois of the animals.

A feature of the cost data given in this book that deserves special mention and commendation is the cost per bushel of storing capacity of various elevators, etc. Rough checks upon detailed estimates carefully made may often serve to show up large errors, and a price per bushel of capacity is a good basis upon which to estimate whether or not a plant will pay.

The experimental data cited in the book add to its value as a guide in design, and bringing together this matter allows a comparison to be made, not only between experiment and theory, but between the results as found by different experimenters.

In the matter of design little is given, reference being made to the author's book on "The Design of Mill Buildings." The principles of design applicable to this special branch of construction are not adequately set forth. For example, Professor Ketchum gives no hint as to how he would provide for a torsional moment in a circular girder, the stresses in which he minutely calculates on the assumption of a simple moment and no torsion at the supporting posts. On page 137 Professor Ketchum recognizes the annular compression at the junction of the shell and conical bottom of a bin, due to the weight of the contents of the bin hanging on the bottom sheets in their inclined position, giving an inward thrust which must be resisted at the corner. He, however, puts this down as a stress in the circular girder supporting the tank. Now this cannot be transmitted to the circular girder, unless the girder is continuously connected to the tank; and if the girder is so connected to the tank, the whole shell of the tank is a circular girder; and the principle office of this nominal girder is to take the annular compression and the small bottom flange stress of the shell as a circular girder. It is just a trifle absurd to give expressions to the fifth decimal place for the bending moments in a circular girder which supports a circular girder directly over it (the tank shell) that is immensely stiffer than itself. The vital point in the strength of a tank with a conical bottom or with a segmental bottom is this annular compression at the junction of shell and bottom. If there is not a circular compression member rigidly and continuously attached to the tank, it is faulty in design and liable to failure. The circular girder, as a girder, is of no importance; it merely acts as a connecting medium to the columns. It is the overlooking of such incidental and apparently trivial points in design that gives rise to more failures than anything else. This annular compression is merely mentioned, while more than four pages are taken up with a discussion of the stresses in a circular girder based on a purely arbitrary assumption. A circular girder could be made that would be perfectly safe with a hinge where this discussion finds a maximum bending moment.

Another thing that might have been mentioned is the effect of inclined posts supporting a tank and means of taking the horizontal thrust at the top of the posts due to the inclination. On account of failure to provide for this thrust at the top of posts in a large tank the writer was recently called upon to decide whether or not to condemn a tank that had a serious case of bow legs and a tendency to turn the foot walk into a ruffle. It was decided to operate upon it by inserting struts to take the thrust. In the writer's opinion the best treatment of inclined posts is to use vertical posts. Inclined posts, jamming into the sides of the tank, tend to destroy its circular shape and to spring leaks.

For riveted joints in tanks the author recommends the same units for tension, bearing and shear as are commonly employed in building work, namely, 16,000, 22,000 and 11,000, respectively. The usual practice is to use 60,000 lbs. for tension and bearing and about 40,000 for shear, and then to apply a factor of safety, say of 3 or 4. He does not use the familiar and universal term, bearing, in speaking of rivets but calls it compression, a term which is confusing. His discussion-in-chief on riveted joints in circular bins assumes drilled holes, and he uses the diameter of hole for the diameter of the rivet; the deduction of ⅛-in. extra for punched holes is mentioned as though it was rare to punch the holes or to make this deduction. Drilled holes in the sheets of an ordinary circular bin would scarcely be thought of, and rivets are universally calculated on the basis of their diameter before driving.

The author mentions the fact that grain elevators are called silos in Europe, but he does not take note of the silo of this country, which is a tank or bin to contain fresh-cut cattle food. These are used by farmers. Some data on their design would be a valuable addition to the book.

In his discussion on reinforced concrete the author wisely refrains from mention of patented fads. He says on page 304 that experiments have shown that concrete columns reinforced with longitudinal reinforcement and having a length not to exceed 25 times the least diameter will have an ultimate unit strength 2,000 times (area of concrete plus n times area of steel), where n is the ratio between the moduli of elasticity). According to Bulletin No. 10, of the University of Illinois Experiment Station, page 14, this is not true. Some recent disasters seem to have been due to the excessive weakness and lack of toughness of columns reinforced with longitudinal rods. The author recommends a unit stress in high steel used in reinforced concrete of 25,000 lbs. per sq. in. Such high unit stresses cannot be too severely condemned. The modulus of elasticity of high steel is the same as that of low steel, and stress of this intensity is sure to crack any concrete by the stretching out of the steel. On page 64 the author figures the counterfort of a retaining wall as a beam, instead of taking it merely as a protection of the rods needed to tie together the horizontal slab and the front wall. On page 62 he finds a shear which he calls a vertical shear, though it is on a horizontal surface. The actual vertical shear below the point D, due to the upward forces on the projecting slab, is of double the intensity found by him in the vertical wall. He uses a curve in a rod as an anchor. Experiments and theory are against this.

The most disappointing feature of the book is the treatment of theory, of which there is too much. Nearly 40 pages are taken up with various theories of retaining walls. If anything tends to cast discredit upon theory, it is complex theories of retaining walls. The author makes a defence, in his introduction, of these theories by citing bridge theories and the apparent inconsistencies there between theory and fact. It is true that such parts as pins closely packed may be over safe when designed strictly by theory, but no bridge would stand up with the pins removed. Trains were never known to traverse space in a horizontal direction with no supporting structure. Earth, however, will very often stand vertical, or even overhang, with absolutely no retaining wall of any kind. Elaborate theories that prove the existence of great pressures of this earth can scarcely claim serious consideration. It is true that in the case of sand, grain, or other granular substances actual pressures are realized, but as long as simple theories are possible, there can be no use of complex ones, until it is proven that the simple ones do not give consistent or approximately true results.

Professor Ketchum, in a problem in retaining walls, assumes sand as a filling and a surcharge at the angle of repose. Sand, while it is used in some unusual cases as a fill back of retaining walls, such, for example, as the track elevation work at Chicago, is not a standard material, and would demand tight walls, if used. Sand is too unstable a material to lie in slopes at an angle of 35°. The rain would beat it down and over the wall, and the wind would lift it. A wedge of earth back of a retaining wall is apt to be loosened by rain and to slide down against it with great force. The freezing of the fill back of the wall and the consequent expansion is the most potent force in overturning retaining walls in temperate regions. These are the two factors opposing the stability of retaining walls. The latter finds no mention in this book. It should be forestalled by drainage. A simple formula that will give approximately the effect of these wedging forces is all that the conditions of the case demand. This the theory which Professor Ketchum attributes to Trautwine fully meets, not because it is theoretically correct, but because it is approximately so and gives walls that experience has shown to be thick enough.

In the theory of the pressure of grain in bins, after giving Janssen's solution, which is a formula simple of derivation and of application and one that tests have shown to give very close to the actual pressures of grain, another solution is given that is very complex and difficult of application.

The average engineer would be stumped at an expression like this: $e^{-\frac{n\,y}{2.3}}$. Common logarithms in a formula are difficult enough of solution. This expression could be written thus:

$$\text{Number whose common log. is } \frac{n\,y}{2.3}.$$

This is much more trouble to print, but there is less liability to make an error in the solution. Negative exponents of the Naperian base are puzzling.

On page 162 attention might have been called to the fact that a uniformly varying load on a beam may be very quickly solved by taking the average load. The variation from the true maximum moment, the solution of which is quite long, is very small.

Short cuts and close approximations, while they do not satisfy the sensitive mathematical nature, are of immense benefit to the designer and are eminently in place in a book on design. We are, or should be, getting further and further away from the historic toast: "Here's to Mathematics, may she never be of any use to anyone."

EFFECT OF SCALE ON THE TRANSMISSION OF HEAT THROUGH LOCOMOTIVE BOILER TUBES.—By Edward C. Schmidt and John M. Snodgrass. Bulletin No. 11, University of Illinois Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6 x 9 ins.; pp. 24; ten illustrations, partly in the text.

For many years past there has been no little discussion as to what extent accumulations of boiler scale affect the transmission of heat and the consumption of fuel in actual practice. The data accumulated have been so varying that in 1898 the Railway Engineering Department of the University of Illinois started a series of comparative experiments and tests with the hope of developing, at least approximately, laws for the variation of conductivity, for varying thickness, character and composition of the scale.

The first series was made in 1901, with a freight locomotive, Rogers type, of the Illinois Central Railroad. The last three series reported in this pamphlet, those of 1901, 1904 and 1905, consisted entirely of laboratory experiments on various boiler tubes furnished by railroads of the middle west. It was attempted to arrange practically uniform conditions in everything except the scale itself. The methods of tests and experiments are explained and the results shown in tables and diagrams. The hope of the experimentors, in establishing laws of conditions, has not yet been realized.

HAND-BOOK OF TIMBER PRESERVATION.—Souvenir Edition, Revised. By Samuel M. Rowe, C. E., M. Am. Soc. C. E. Chicago, Ill.: The Author (Monadnock Building). Leather; 4 x 6¼ ins.; pp. 328; plates and text illustrations. $5.

The 1905 edition of this work was reviewed in our issue of Dec. 14, 1905, and was followed by an enlarged edition in 1906. This latest edition of 1907 has 74 pages more than the previous one. The new matter includes recent discussions on the seasoning and steaming of timbers, and particulars of the use of crude oil as a preservative for railway ties. There is also a paper by Mr. O. Chanute, M. Am. Soc. C. E., on the steaming of timber, and a reprint of the article by Mr. Rowe on "The Outlook for Timber Preserving Processes in the United States," which was published in our issue of Jan. 17, 1907.

Hydro-Electric Plants.

DESIGN AND CONSTRUCTION OF HYDRO-ELECTRIC PLANTS.—Including a Special Treatment of the Design of Dams. By R. C. Beardsley. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 512; 480 illustrations in the text, and 76 tables. $5, net.

This work presents in a very thorough and practical manner the method of the design and construction of hydro-electric power plants, taking up in detail, in the order in which they are met by the practical engineer, most of those points which must be considered in designing or constructing a complete water-power development. The purpose of the work seems to be to give to the designing engineer, in as short and as concise manner as possible, the method in which the various problems are attacked, including under each topic most of the data and tables which he is required to use in connection therewith.

Although probably intended for the practical engineer, the work contains much that will be found of value to teacher and student, in that valuable matter is included which is not often found in text-books or other works of this nature and can usually be obtained only from the men who are directly interested in a project, either as engineers or as contractors.

The book opens with a short chapter on hydraulic principles. This is followed by one which treats in a very thorough manner of the measurement of the flow of water over weirs, through penstocks, canals, etc. A number of useful curves are given, from which the value of the coefficient, C, in the weir discharge formula, $Q = C\ L\ H^{\frac{3}{2}}$, may be found for six different types of crests of dams. Another set of curves which will be found of convenience to the engineer are those giving the value of the coefficient, C, in Kutter's formula, $V = c\sqrt{r\ s}$, for water flowing in penstocks and canals for the different values of n and for any hydraulic radius, r. Several examples are given indicating the method of their use.

Twenty-eight pages are devoted to a discussion of the manner in which the first investigation of a water power is made, the author devoting considerable space to describing the use and method of making up the data on rainfall and run-off for various rivers and streams given in the U. S. Geological Survey Reports; but little is said of the use of the tables furnished by the government giving actual gage reading of flow in which the engineer is more directly interested and for which he is in greatest need.

Under the subject of materials, the author takes up at some length a discussion of the various uses, etc., of the different materials used in construction. Considerable space is devoted to cements and concrete and testing the same and, although much of this information is more or less familiar to most practicing engineers, its conciseness makes it useful for reference.

Practically one-third of the book is on hydraulic construction, with special reference to dams. The usual methods employed in construction work are described and explained, together with a description of some of the machinery commonly used in construction work. The design and construction of dams of all kinds is discussed quite fully and the reader is given the benefit of the wide and varied experience of the author in this branch of engineering.

The remainder of the book, some 163 pages, is devoted entirely to the power house, power transmission and the equipment for same. Illustrations are given of a number of well-known power plants; and also of good designs for special conditions. Each detail of the power house equipment and transmission line is discussed, giving a general idea of the function of each and a description of the apparatus usually employed in modern practice.

The subject which the author has treated is of such magnitude that it is almost impossible to cover every detail thoroughly and give all of each that may be of value, but he has, however, succeeded in covering the subject admirably well and has brought within the reach of the engineer and student much valuable information.

Interspersed throughout the text, and also included in a short chapter at the end, are many tables and formulae which will be found of use for reference.

Most of the illustrations are line drawings and sketches, but there are also a few half-tones. A very good grade of a dull finished paper is used; the type is of a good size and few typographical errors are noted.

Altogether the book will be found to contain much of value to the student and to teachers and will be a valuable addition to the engineer's reference library. A. W. M.

ELECTRICAL FEATURES.

This work is prepared from the standpoint of the hydraulic engineer, although some 100 pages of the portions on power-house equipment and power transmission deal with the purely electrical apparatus.

Switchboards, instruments, lightning arrestors, transformers, storage batteries, transmission poles, insulators and cables, are given a terse treatment, in which it is attempted to mingle bits of practical advice, small amounts of detail and data, with the prominent features of such apparatus. The result is a poor perspective to an electrical engineering reader. However, it may be that the author has aimed to present such electrical matter as would be convenient to connect the hydraulic investigation to a deeper study of the electrical problems. If such is the author's aim—to stimulate and direct a further study—he has succeeded. Few would attempt to plan the electrical design merely on what is given by the author.

One feautre of the book, which is noticeable and pleasing, is the interspersion of bits of material which many young practicing engineers will copy into their ready reference books for handier and quicker access. Of such material may be mentioned the numerous items of cost, useful in estimating.

Physical Properties of Cement and Concrete.

CEMENT AND CONCRETE.—By Louis Carlton Sabin, B. S., C. E., M. Am. Soc. C. E., Assistant Engineer, Engineer Department, U. S. Army. Second Edition, revised and enlarged. New York: McGraw Publishing Co. Cloth; 5¾ × 9¼ ins.; pp. 572; illustrated. $5, net.

In reviewing the first edition of this book (April 13, 1905) we said that the title might in propriety be changed to "The Physical Properties of Cement and Concrete," inasmuch as the greater part of the work was devoted to testing and the results of tests. The principal portion of its contents related to the manufacture of cement, the mixing of concrete and to concrete as a material; only a minor section was devoted to concrete construction and to reinforced concrete, the development of which has caused the enormous growth in the cement industry.

The restricted field of Mr. Sabin's book is even more noticeable to-day than when the first edition was issued, owing to the publication in the last two years of two new books and one revised edition of an old book (Reid, Twelvetrees and Buel and Hill) all of which pay particular attention to concrete construction and to reinforced concrete. There is a distinction to be made in concrete literature between text-books on material and those on construction. Necessarily each contains some of the important points which rightly come under the other subhead, but only in such a general way as to give impressions which may be enlarged and confirmed by the other book. It is no adverse criticism to say that Mr. Sabin's book is distinctly of the former class, for in it construction plays a subordinate part to the material.

The second edition has been enlarged from 507 to 572 pages, two pages of which have been added to the chapter on "Definitions and Constituents," 12 pages to the chapter on "Manufacture," and the remainder to a new chapter on "Concrete Building Blocks; their Manufacture and Use," and to three appendices giving the standard specifications for cement adopted as suggested by committees of the American Society of Civil Engineers, American Society for Testing Materials and American Chemical Society. Nothing has been added to the already brief chapters on concrete construction, nor have the portions on testing been changed at all. The criticisms noted in our previous review therefore still hold. The additions in the chapters on Constituents and Manufacture have all been for the better; illustrations have been added in the descriptions of the various mills, and the sections on the little used semi-wet process has been shortened considerably from its disproportionate length in the former edition.

The book as it now stands is an admirable treatise on concrete as a material, but must be taken in connection with some reference book of design and construction to make a complete survey of the field of what may be called concrete engineering.

Tenth Thousand Now Ready

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COST
DATA

BY

HALBERT P. GILLETTE, M. Am. Soc. C. E.

Morocco, gilt edges, 4½ x 7 ins. 622 pages. Illustrated. Price $4.00 net postpaid.

The Myron C. Clark Publishing Co.
357 Dearborn Street, Chicago, Ill.

THE QUEBEC BRIDGE.—Building for the Quebec Bridge & Railway Co. New Liverpool, P. Q., Canada: N. R. McLure. Stiff paper; 9¼ × 7⅛ ins.; illustrated. 35 cts., postpaid.

As our readers will recall, the Quebec Bridge is to be the greatest bridge structure ever erected. The present pamphlet contains a dozen or more photographs of the structure in process of erection, with descriptive matter giving the principal particulars concerning the bridge and the methods of work employed upon it. The erection of the enormous members of the bridge involves many problems of greater magnitude than have ever before been solved in this field. The main post members, for example, are erected in sections weighing 92 tons each, and the tops of these main posts are 400 ft. above the water. Another interesting feature in connection with the erection is that the entire work is done by electric power, generated by water power at the Chaudière Falls; thus the entire work of placing this great structure over the St. Lawrence will be furnished by the falling water on one of the tributaries of that river.

Third Thousand Now Ready

Concrete and Reinforced Concrete Construction

BY

HOMER A. REID, Assoc. M. Am. Soc. C. E.

Cloth, 6 x 9 ins. 906 pages; 715 Illustrations; 70 Tables. Price $5.00 net postpaid.

This book is the recognized authority on the subject.

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Denatured Alcohol.

Reviewed by CHARLES EDWARD LUCKE,* M. Am. Soc. M. E.

DENATURED OR INDUSTRIAL ALCOHOL.—A Treatise on the History, Manufacture, Composition, Uses, and Possibilities of Industrial Alcohol in the Various Countries Permitting Its Use, and the Laws and Regulations Governing the Same, Including the United States. By Rufus Frost Herrick, Consulting Chemist and Chemical Engineer. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 516; 163 illustrations, mostly in the text. $4, net.

The enormous increase in engineering knowledge in recent years has made it necessary for the successful practice of engineering that the available information be classified under certain special headings and the persons practicing any particular branch have come to be known by special names. Thus, while some years ago there were only Civil Engineers and Military Engineers, there are now Mechanical, Electrical, Chemical, Heating and Ventilating, Refrigerating and a great variety of others, some justifiable and others not. The separation of knowledge and the practice of engineering, therefore, into specialties has become necessary, but equally necessary is a re-combination or re-grouping from time to time as demanded by circumstances.

This book is an illustration of the latter point. It is an attempt, in view of recent legislation on denatured alcohol, to present to the public a book that would appeal to the chemical manufacturer of alcohol on the one hand and the engineer who would use it as fuel on the other hand. It, therefore, attempts to combine information of an almost purely chemical sort with information on mechanical engineering, more especially the internal combustion engine. Such a book might be written by a chemist or a mechanical engineer, but it is very unlikely that a single man could be found equally well qualified to write from both points of view. Mr. Herrick is a chemist. The result is that his knowledge of engineering, as shown by this book, is very meager and in some cases incorrect. In practically all cases it is not first-hand knowledge that is presented, but borrowed. It is doubtful whether the book was intended to appeal to the chemical manufacturer of alcohol or to the engineer. As an engineer more than usually familiar with the internal combustion engine using alcohol fuel the reviewer can unqualifiably say that this treatment of the subject is absolutely misleading. The treatment of the alcohol-manufacture part of the book seems to partake of the same characteristics, although it is more fully written, noted for the engineering section of the book, to wit, superficiality and a dependence on other than first-hand information.

The illustrations presented in many cases fail to show what they were intended to show; that is to say, they fail by reason of their form to give detailed information on the structure of the part in question and its functional operation, and seem very largely to be taken from catalogues. Thus, on page 168, Fig. 66 is entitled Hot Air Motor Driven by Denatured Alcohol (furnished by Elmer & Amend). This same illustration will be found in the Elmer & Amend Catalogue on page 56, marked therein No. 9252b. The inaccuracy of the information is very well illustrated by the statement in the text that this is a denatured alcohol motor, whereas it is nothing of the sort. It is a little hot air engine, which may be driven by any source of heat (gas burner, or kerosene lamp) just as well as by denatured alcohol. Furthermore, it is stated that "these motors are operated by the expansive force of hot air." The reviewer does not know what the expansive force of hot air means and is quite sure that no one reading the text could get an accurate notion from the book.

The book begins with a treatment of the raw materials for making alcohol, in which the machines illustrated are only half described and the structure in most cases not at all clear. No dimensions of the apparatus are given, although the capacities are. There is no assistance in this part of the book to any one contemplating the installation of mills, although it might be supposed that this was intended by the general arrangement of the text. No figures on the power necessary to operate the machinery are anywhere to be found. The relation of vapor pressures and the theory of distillation to the boiling point of mixtures is asserted, but the author does not show how the boiling point may be calculated or how the boiling point of a given mixture may be determined from the vapor pressure curves. The real meaty, scientific quantitative treatment of all important questions is plainly dodged. The statement on page 68, "It is unnecessary in a book of this sort to give the rigorous proof of this theorem," relating to the theory of fractional distillation by Konowalow, is a fair illustration of this attitude. Wherever one might expect to find the quantitative treatment it is always omitted. In the discussion of the question of percentage of alcohol and its relation to the density of the mixture no mention whatever is made of the difficulty experienced in reconciling the tables of different authorities, whereas to any one who is really familiar with the question it must be known that the different tables do not give consistent results.

In Chapter V., entitled "The Cost of Alcohol and of Alcohol Distilling Plants," there is a reproduction of a photograph illustrating the harvesting of potatoes. The men, horses and wagons are all clearly marked, but it is difficult to see the relation between this and the cost of alcohol. In this same chapter there is no relation shown between the cost of the raw material and the cost of alcohol produced, which is really a very essential question. The cost of textile mill buildings is quoted from C. T. Main on pages 186 to 199 and is evidently presented for the purpose of enabling prospective mill builders to estimate the cost of the building structure, but no figures are given on the more pertinent question of how many feet of floor space, or how much load per sq. ft. of floor space, should be allowed for alcohol distilleries.

The alcohol lamps illustrated on page 214, and designated as Boivin Incandescent Mantle Lamp, are described, but the lack of statement of the difficulty of handling these lamps, involving the spilling of alcohol through the operation of the piston, indicates that the information presented is taken from some statements of the manufacturer and not from first-hand knowledge of the goodness of the lamp.

On page 244 there is found a heading, "Thermal Efficiency of the Fuel," which is defined later as the ratio of the heat units expended in useful work to the original heat units available in such a fuel. This is a very loose treatment of a very important question. A fuel cannot have an efficiency, but the apparatus or method of using the fuel may. Equally loose is the statement found on page 245, in relation to the same question, that the highest efficiency of an engine (internal combustion) will be attained when the exhaust gases have the lowest possible temperature. This may or may not be true. It all depends; but the dependence is not at all discussed.

In the discussion of kerosene and gasoline, pages 248-258, 72° gasoline and 135° fire-test kerosene are discussed, and at the same time, in the calculations on the air necessary for combustion, gasoline is assumed to be hexane and kerosene is assumed to be decane. Not only is this inconsistence not clearly pointed out, but worse still, the author does not mention the fact that kerosene and gasoline are not simple substances and that if partially distilled or vaporized the temperature will continually rise, and that the air for combustion, and the difficulties of vaporizing and using these fuels in engines, are very largely dependent upon this important fact of complexity of chemical and physical characteristics of the commercial articles sold for kerosene and gasoline.

A rather amusing thing will be noted on page 259, where a Beaumé hydrometer is illustrated in Fig. 110, and right opposite, Fig. 111, a hydrometer jar is also illustrated, but for the scale used in these cuts the hydrometer would never go into the jar. This is not a matter of great importance, but illustrates the point mentioned heretofore, that the book is loosely written. Of the kerosene burner for steam automobiles, illustrated on page 274, it is stated that it is easily adaptable for use with alcohol." One would like to know how.

A good deal of the description of the Otto alcohol engine, on page 278, is applicable to any engine of a similar class, so that a person reading this chapter might assign to the Otto engine virtues that equally well belong to nearly all the rest. This whole description of the Otto engine reads very similarly in parts to advertising matter issued by the Deutze Co. or its American representative. The statements apparently have been published as received, without discussion.

The Meitz & Wiess engine is described on page 290 and there is found the following statement: "In the building of alcohol engines by this firm the only change necessary is to increase the compression over the kerosene-oil engine which they have so long supplied and the merits of which are so well recognized." Not only does this sound a little like advertising, but it is inaccurate as well, because the injection orifice and pump stroke must be increased for alcohol and there is no necessity for an increase in compression. The increase is rather a desirable thing, but not by any means necessary. The reviewer has been trying without success to decide why Fig. 152 is inserted. It is entitled "Gasoline-traction or Plowing engine, built by

*Adjunct Professor of Mechanical Engineering, Columbia University, New York City.

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357 Dearborn Street, Chicago, Ill.

the Hart-Parr Co., Charles City, Ia. This engine can be easily adapted for use of alcohol." If it is so easily adaptable why did not the author say how? The same tendency toward advertising statements is illustrated on page 302: "The demand for Olds Engines has been constantly increasing."

In connection with the Diesel engine, there is no attempt to discuss the relative difficulties of handling with pumps and injection nozzles liquid fuels of heavy or easily volatile types, whereas such real difficulties exist. There is a somewhat pretentious treatment of the methods of testing internal combustion engines, which makes one wonder why in the absence of definite information on the construction and operation the author saw fit to give any space at all to the testing.

Probably the climax of inaccurate statements of facts is found on page 319, under the heading "Comparison of the Economy of Steam Engines with Other Types of Engines," to which is devoted about four pages. The best that can be said of this is that it as weird and wonderful as it is unsatisfactory.

A careful reading of the book by any one even partly well informed on the subject matter must lead to the conclusion that the author was very unfamiliar with his subject; that he depended almost entirely on other than first hand information; that he was unable or unwilling to criticise this information when obtained; and that the purpose of the book is not so much the presentation of a treatise of the history, manufacture, composition, use and possibilities of industrial alcohol for the use of the engineer, chemist, manufacturers of alcohol apparatus, including engines, lamps and stoves, as to get quickly before the public, stimulated by the recent legislation, a work of any sort that pretended to give that for which there is now a strong demand.

Machine Tools.

Reviewed by WILLIAM W. BIRD.*

MODERN AMERICAN MACHINE TOOLS.—By C. H. Benjamin, M. Am. Soc. M. E., Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, O. New York: E. P. Dutton & Co. Cloth; 5½ x 9 ins.; pp. 320; 134 illustrations in the text. $5, net.

The author's reason for writing this book is that all books hitherto published along this line have treated the subject mainly from the standpoint of the apprentice or journeyman, and consequently there must be a place for a book on machine tools from the purchaser's point of view. This is a good argument for the undertaking, and Professor Benjamin has brought out a book which probably comes as near accomplishing his object as could be expected. He gives a good outline of the principal characteristics of modern machine tools, as manufactured in the United States, the various points in which they differ, the advantages and disadvantages of different styles, and some data in regard to their capacity and performance.

Naturally a work of this sort is more or less of a scrap book, with clippings from the various trade catalogs, but as the compilation has been made by an excellent authority on the subject the book is a valuable one and well worth consulting. There is, however, one important fact to be remembered which lessens the value of the book to the buyer of machine tools and that is the impossibility of getting the latest and best information from a book. The time that must necessarily elapse from the placing of a new machine on the market and the first write ups in the trade papers, to the publishing of the final book, is ample time in which to make many changes so that the book is bound to be a back number. In this case, it would be safe to say that this book is now two years behind the times and that if one wished to know the very latest developments in machine tools it would be necessary to send to the makers for their 1907 printed matter.

There are many good data on electric drives, based on the author's own experiments, which add to the value of the book. The illustrations are very good and the descriptions clear and concise. The high-speed steel has accomplished wonders in the evolution of machine tools, and when the present uncertainty has settled into a more definite type and form, it is to be hoped that Professor Benjamin will bring out a new edition of this book which will have a more lasting value.

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The Railways and the Public.

RAILWAY PROBLEMS.—Edited, with an Introduction by William Z. Ripley, Ph. D., Professor of Economics, Harvard University. Boston and New York: Ginn & Co. Cloth; 5½ × 8½ ins.; pp. xxxii + 686; illustrated. $2.25.

The railway problems to which this work is devoted are the problems which grow out of the relations between the railway and the public; and we hardly need say that these problems have been in the focus of public attention and discussion for a year past. To a considerable extent these problems are coming before the engineering profession. Engineers are engaged in the work of railway valuation, and are in the service of the commissions which have the duty of passing upon rates. The discussion of these current problems in this book, therefore, while written primarily for students of economics, must interest many engineers.

The book is a compilation of 27 papers written by different authors and previously published in periodicals or elsewhere. It begins with a reprint of Hon. Chas. Francis Adams' famous "Chapter of Erie," a story of the corrupt deals by which in the late '60's Jay Gould, Cornelius Vanderbilt, Daniel Drew and Jim Fisk used the Erie Railroad as a counter in a gigantic game of speculation and fraud. The methods used by the Wall St. sharks of that day were perhaps more bold than those now approved in the realms of "High Finance." It is interesting to notice, however, that the Erie Railroad wreckers whose high-handed outrages so shocked honest men forty years ago, used to clear only modest hundreds of thousands in their deals and steals. This seems picayune indeed compared with present-day performances, when the insiders who engineer such a combination as the American Tobacco Trust are able to clear up a profit of forty million dollars.

The second chapter of the book is a reprint of Miss Ida Tarbell's story of the Standard Oil Rebates, a particularly interesting document in view of the recent public statement by Mr. Rockefeller that his company has never benefited by rebates! The third chapter is the story of the building of the Union Pacific Ry., taken from Mr. Henry Fiske White's book. These three opening chapters dealing with some of the most notorious of the abuses of American railway management, are a good illustration of the problems that those who would reform present-day evils by Government supervision must face.

The following fifteen chapters are reviews of the rulings of state and national railway commissions and of the courts, relative to the adjustment of railway rates; and will be followed only by careful readers who desire to make an exhaustive study of the subject.

Chapter 19, by Mr. Ripley himself, entitled "Economic Waste in Transportation," is a discussion of the waste caused by the system of competing routes and rates made regardless of distance, and deserves the careful study of every railway officer and every one who would form an independent opinion on the relative merits of state ownership of railways and of the competitive system of private ownership.

Prof. Meyer, of the University of Wisconsin, contributes a chapter on the Northern Securities Consolidation, which President Roosevelt's administration nipped in the bud, and Prof. Dixon, of Dartmouth, discusses the Interstate Commerce law as amended in 1906. Then follow two chapters discussing the basis of a reasonable rate and the much talked of "Court Review" requirement. The concluding chapters relate to the practise of England, France and Germany in the solution of these problems.

We can very heartily commend the book to anyone desiring to make a study of the economic relations of the railways to the public.

John Wiley & Sons'

Scientific Publications

TENTH ANNUAL CONVENTION OF THE ASSOCIATION OF STATE AND NATIONAL FOOD AND DAIRY DEPARTMENTS. (Interstate Pure Food Commission.) Held at Hartford, Connecticut, July 17-20, 1906. 8vo, vi + 349 pages. Cloth, $3.00.

HUBBARD & KIERSTED — WATER-WORKS MANAGEMENT AND MAINTENANCE. 8vo, vi + 429 pages, 111 figures, 18 plates. Cloth, $4.00.

MERRIMAN-JACOBY—A TEXT-BOOK ON ROOFS AND BRIDGES. Part IV. HIGHER STRUCTURES. Third Edition, Revised and Enlarged. 8vo, cloth, $2.50.

HERRICK — DENATURED OR INDUSTRIAL ALCOHOL. A Treatise on the History, Manufacture, Composition, Uses, and Possibilities of Industrial Alcohol in the various Countries permitting its Use, and the Laws and Regulations Governing the Same, including the United States, with concise Tables, Methods, and Notes for the Use of the Engineer, Chemist, Manufacturers of Alcohol and Alcohol Making and Using Apparatus, including Alcohol Motors, Engines, Illuminating Lamps, and Heating and Cooking Stoves. 8vo, ix + 512 pages, 163 figures. Cloth, $4.00 net.

WHIPPLE — THE VALUE OF PURE WATER. Large 12mo, viii + 84 pages. Cloth, $1.00.

TITSWORTH—ELEMENTS OF MECHANICAL DRAWING. In Two Parts. Part I. For Beginners. Exercises in the Use of Instruments and Use of Scales, and Simple Problems in Projections, Intersections, and Developments. Part II. Problems in Descriptive Geometry. Oblong large 8vo, vi + 130 pages, including 41 full-page plates. Cloth, $1.25 net.

CREIGHTON—THE STEAM-ENGINE AND OTHER HEAT-MOTORS. 8vo, xii + 499 pages, 198 figures. Cloth, $5.00.

MERRIMAN—TREATISE ON HYDRAULICS. Eighth Edition, Rewritten and Enlarged. 8vo. Cloth, $5.00.

WEBB—THE ECONOMICS OF RAILROAD CONSTRUCTION. Large 12mo, viii + 339 pages, 34 figures. Cloth, $2.50.

RICE — CONCRETE-BLOCK MANUFACTURE: PROCESSES AND MACHINES. 8vo, xiv + 152 pages, 46 half-tone cuts. Cloth, $2.00.

SCHWARZ—THE LONGLEAF PINE IN VIRGIN FOREST. 12mo, x + 135 pages, 23 full-page half-tone illustrations and 3 diagrams. Cloth, $1.25.

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NEW YORK CITY

Topographical Drawing.

Reviewed by H. M. WILSON.*

A TEXT-BOOK OF TOPOGRAPHICAL DRAWING.—By Frank T. Daniels, A. M. B., Author of "A Text-Book of Free-Hand Lettering." Boston, Mass.: D. C. Heath & Co. Cloth; 7⅛ × 5⅜ ins.; pp. 144; 56 illustrations in the text and 10 plates. $1.50.

At first thought it would appear that there was no room for an additional text-book on topographic drawing. There are already in the market a number of excellent treatises on topographic surveying, covering in part topographic drawing; also on surveying in general, and on drawing, on lettering, on mechanical drawing, etc. A brief glance at Mr. Daniels' book, however, makes it immediately evident that here is a book that makes a field of its own, and for which there is a place on the shelves of all engineers and surveyors who have to do with topographic drafting. From the contents of this book it is evident that Mr. Daniels has confined himself strictly to his title. He does not go afield into lettering or mechanical drawing, nor does he waste time in the description of the drafting instruments or methods with which engineering and architectural draftsmen are familiar.

The first chapter deals briefly and concisely with the instruments and materials required in topographic drafting. The next two chapters take up the subject of paper and of plotting. The remaining chapters take up the subjects of drafting and the symbols used in drafting topographic maps, in ink and in colors, and the methods of representing surface form. This is followed by a brief treatise on earthwork and earthwork computation as based on contour topographic maps; on the conventional treatment of materials of excavation and construction, including geological sections and profiles, and finally a chapter on copying, reduction and enlargement of plans.

The book is concisely and clearly written. It is well divided by bold type into the separate subjects; is well and clearly illustrated by original drawings, presumably by the author, and is altogether so complete and yet so well edited that the most experienced topographic draftsman will find information of value to him in it, while the novice can practically take a course in topographic drafting by following the pages and examples. Some good points with which skilled draftsmen are familiar, but which are helpful knacks clearly described for use of those not familiar with them, are the description of the methods of splicing drawing paper, and of patching tracing cloth. The chapter on topographic drawing in colors is especially well adapted to teach from a text-book the method of making washes and of using color on drawing paper. All the symbols reproduced in this chapter and in the preceding one, on ink drawing, are standard, and follow closely those adopted by the topographic branch of the U. S. Geological Survey, the Coast Survey and the Army. The chapter on contour construction and contour interpolation is especially lucid and goes into features of the subject not treated elsewhere, though this latter statement applies practically to the whole book. The summary of principles governing contouring will be most helpful to beginners, while the more expert will find meat under the heading of Determination of Slopes and Intersections. Under the topic of Earthwork, the method of measuring volumes from contour maps and the discussion of the prismoidal formula are well and clearly set forth.

In reviewing so well written a text-book it seems ungracious to be critical over trifles. The copying glass illustrated on page 11 is undoubtedly well calculated to perform the work; nothing better than the electric lamp used under glass in this general manner can be suggested. On the other hand, a much simpler and cheaper apparatus which will fulfil the purpose equally well can be arranged by resting a piece of heavy plate glass on a couple of blocks on the top of the drafting board, and laying under this one or more electrical lights attached to movable wire. The needle point or pricker with wooden handle, described on page 12, is a little difficult to make. A simpler and equally effective one can be made by melting a globule of sealing wax about the needle as a handle. On the subject of azimuth, on page 33, the author states that "there is no agreement among surveyors as to whether the azimuth should be read from the south by the way of west, etc., or from the north in the same direction." There may be no such agreement among what are known as common surveyors, but among geodecists and topographers, especially those having to do with such work in a large way for the foreign or for the American Government, there is one standard way of reading azimuth, and that is from the south by way of west and north, and not from the north.

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BOARD OF RAPID TRANSIT RAILROAD COMMISSIONERS FOR THE CITY OF NEW YORK.—Report for the Year Ending Dec. 31, 1906. Accompanied by Reports of the Chief Engineer and of the Auditor. New York: The Board (Bion L. Burrows, Secy., 320 Broadway). Paper; 6¾ × 10¼ ins.; pp. 355; numerous folding and other plates.

The New York Rapid Transit Commissioners having been succeeded on July 1 by the Board of Public Utilities, this will be the last report of the first-named board. The report opens with a brief review of the history of the Commission and its work, and a more detailed statement of the general run of events during the past year or so, including the final selection of a large number of additional tunnel routes. In the detailed report of Mr. George S. Rice, M. Am. Soc. C. E., Chief Engineer, is the report on the air in the subway, made some time ago by Dr. George A. Soper, and also a brief description of experiments at the Brooklyn Bridge on cooling the station air by means of water from artesian wells, circulated through a pipe system. The last-named report was made by Mr. John E. Starr. Many financial and other statistics are included in the report, and also a large number of half-tones and of folding sheets of maps and drawings.

REPORT ON THE ORIGIN AND PREVALENCE OF TYPHOID FEVER IN THE DISTRICT OF COLUMBIA.—By M. J. Rosenau, L. L. Lumsden and Joseph H. Kastle. (Including articles contributed by Ch. Wardell Stiles, Joseph Goldberger and A. M. Stimson.) Bulletin No. 35, Hygienic Laboratory, Public Health and Marine-Hospital Service of the United States. M. J. Rosenau, Director, Walter Wyman, Surgeon-General. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 361; folding and other plates and text illustrations.

Inasmuch as this report was made the subject of an article and an editorial in our issue of July 11, it is only necessary at this time to record its publication and to call attention to its value and interest to all who are trying to keep posted on the relation between public water supplies and typhoid fever, and the best methods to be pursued in putting down the disease. As was stated in the issue of Engineering News just named, this is the most comprehensive and extended report on the cause and prevalence of typhoid fever in any city that has ever come to our attention.

DIRECTORY OF DIRECTORS IN THE CITY OF NEW YORK.—(Ninth Annual Edition, 1907.) New York: The Audit Co. of New York. Cloth; 5¼ × 8 ins.; pp. 804. $5.

Besides giving the names and addresses of corporation directors and the various companies with which they are connected, this volume contains selected lists of important New York City corporations, with the names of the principal officers and directors or trustees of each company.

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Shaft Sinking Under Difficult Conditions

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Steel Castings.

Reviewed by BRADLEY STOUGHTON.*

OPEN HEARTH STEEL CASTINGS.—By W. M. Carr. (Compiled from a series of articles by the author, written for and published by "The Iron Trade Review" and "The Foundry.") Cleveland, O.: The Penton Publishing Co. Cloth; 5¼ × 7¾ ins.; pp. 118; 19 illustrations in the text. $1.50.

This little book is a reprint of series of articles which were published in "The Iron Trade Review" and "The Foundry," in 1905 and 1906. It comprises chapters on: Raw materials for acid and basic practice and molding; open hearth furnace construction; fuels and accessories; manipulation of acid and of basic heats; chemical and physical tests; relation between chemical composition and physical properties; blowholes and checks in steel castings; heat treatment and annealing; repairing with thermit, and cost of equipment. Each subject is treated briefly and the information given is well-chosen, useful and accurate, reflecting the author's own experience in practice, and utilizing advantageously the small amount of printed space occupied. Some of the data are very valuable, because they cannot easily be obtained elsewhere. A good example of this is Chapter XII "Cost of Equipping Steel Foundries for the Manufacture of Open Hearth Steel Castings," etc.

A very good opportunity was lost when Chapter X., on "Heat Treatment and Annealing—Consideration of the Relation Between Structure, Heat Treatment and Physical Condition," was made far too brief. The observation of the reviewer teaches that this subject is not understood by foundrymen in general, and, in many cases, even by the best of them. They often do not know enough to realize how bad their practice is. In calling attention to the facts Mr. Carr has contributed a real benefit to the industry. Unfortunately he has treated it in such a condensed form that the reasoning, and especially the advantage to be obtained by correct annealing practice, has to be studied out by the reader rather than having been made clear and emphatic. There is a confusion, too, in the matter of the correct temperatures, due to the fact that the word Centigrade would better have been written on Fig. 14, and that the word Fahrenheit is printed twice on page 107, where it should be Centigrade.† These latter are the only errors noticed in a careful reading of the book, and they do not occur in the original articles (see "The Foundry," December, 1906, pages 256-7.)

The book will be found very useful to any who are engaged in steel foundry practice. It is written in a clear manner and the greater part of it will be comprehensible, even to men who have no technical education.

SWIMMING POOLS.—By John K. Allen, Editor of "Domestic Engineering," Author of "Sanitation in the Modern Home," etc. Chicago, Ill.: "Domestic Engineering." Boards; 4¼ × 6½ ins.; pp. 63; 30 illustrations, mostly in the text. 50 cts.

Descriptions of swimming pools and their construction, and also of their various accessories, are given in this little book. Several methods for making the pools water-tight are figured. A considerable portion of the space is devoted to apparatus for heating water for the pools and to the necessary calculations involved. There being, so far as we are aware, no other book treating this specific subject by itself, Mr. Allen's book is welcome.

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†In this connection it may be well to give a simple and useful rule for annealing castings of about 0.25% carbon: Heat the steel as evenly and uniformly as possible, preventing the flames from striking the metal as much as possible, until it reaches the temperature where it loses all its power to attract a magnet. This point is best determined by having a small piece of steel of the same analysis in the furnace which can be removed and tested with an ordinary horseshoe magnet at intervals. It is never safe to let the steel get much hotter than this, but is slightly advantageous to raise it only 100° F. (This increase is only barely visible to the eye as a change in color). As a general thing if the heating is stopped as soon as the loss of magnetism is observed the steel will be carried at least 100° higher. Keep the furnace closed and as nearly constant as possible for half an hour and then allow to cool. In case the steel has 0.38% carbon, or more, it is not well to heat it the least amount above the point where it loses the power to attract the magnet. If this rule is followed, many and many a casting will be saved from the scrap pile and potently improved in both strength and ductility.

THE FINANCES OF GAS AND ELECTRIC LIGHT AND POWER ENTERPRISES.—By William D. Marks, Ph. B., C. E., M. Am. Inst. E. E. New York: The Author (623 Park Row Building). Cloth; 5 × 7¼ ins.; pp. 540; six folding plates. $4.

Early editions of this book were noted in our issues of Aug. 18, 1904, and July 13, 1905. Five chapters have been added to the present edition. Included in the new matter is a digest of some of the evidence in the recent lawsuit (not yet settled) over the reduction of the price of gas in New York City to 80 cts. per 1,000 cu. ft. There is also included a paper on "Railway Rates for Electric Railways." This paper first appeared in Engineering News of Nov. 2, 1905. The author fails to state this directly, although in a reprint of the Senate Document following, the fact is mentioned incidentally.

The book as a whole contains a large amount of information, statistical and descriptive, on various phases of the subject indicated by the title. But, as the author himself states, no attempt has been made to bring the several papers written at various times, for various purposes, into a connected whole.

THE DROUTH ANTIDOTE FOR THE NORTHWEST. OR THE UTILIZATION OF THE ARTESIAN RESOURCES OF NEW SOUTH WALES.—By Percy Allan, M. Inst. C. E., M. Am. Soc. C. E., Principal Assistant Engineer for Water Conservation, Department of Public Works, N. S. W. (Read before the Sydney University Engineering Society, 10th October, 1906.) Paper; 6 × 9½ ins.; pp. 95; folding and other plates, text illustrations and tables.

After briefly outlining the conditions governing artesian waters in New South Wales, and also the action of the Government for the development of wells and distributary works for the utilization of artesian water, the author presents what is really a monograph on well drilling, the determination of the yield of artesian wells, and methods used for distributing the water for irrigation purposes—all, of course, with special reference to conditions in New South Wales. Well-drilling machinery is described and illustrated in considerable detail, as are also various accessory devices for the distribution of water. A number of tables are given for use in computing the flowage capacity of small earth ditches (called here bore drains), and also for weir discharges from artesian wells. Still more lengthy tables are included for the purpose of exhibiting the location, history and various characteristics of artesian wells in New South Wales, sunk, so far as information is available, up to Dec. 31, 1906. The paper as a whole is a valuable contribution to the literature of the general subject of artesian wells and their utilization in irrigation.

COMMISSIONER OF EDUCATION.—Report for Year Ending June 30, 1905. (Elmer Ellsworth Brown, Ph. D., Commissioner.) Vol. I. Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9½ ins.; pp. ll. + 655; diagrams.

The leading place in the main part of this volume is given to the reports of the Mosely Education Commission on its visit to the United States in 1903. It was the success of engineers of this country, met in South Africa by Mr. Mosely, that determined him to find out "what sort of country it was that was responsible for sending so many level-headed men to the Cape." A few pages are devoted to extracts from a report by Dr. J. Jastrow, of Berlin University, on "Higher Education for Business Men in the United States and Germany." Included in the usual run of statistics, information is presented regarding universities, colleges and technical schools of the United States.

REPORT ON THE LAKES AND GULF WATERWAY.—Message of Governor Deneen and Report of the Internal Improvement Commission of Illinois. Springfield, Ill.: Pub. Doc. Paper; 5¾ × 8¾ ins.; pp. 62.

The Internal Improvement Commission was appointed by Governor Deneen, of Illinois, under an Act of 1905, to investigate the problems associated with a deep waterway from Lake Michigan to the Gulf of Mexico. It was composed of Mr. Isham Randolph, M. Am. Soc. C. E., Mr. H. W. Johnson and Mr. H. M. Schmoldt, with Mr. L. E. Cooley, M. Am. Soc. C. E., as Secretary. The report first reviews the geographic and topographic conditions, and the history of inland navigation in Illinois. It then discusses the lake-and-gulf waterway, 1,625 miles in length, with a fall of 579 ft. below Chicago datum. In this connection it states that under specified conditions a depth of 14 ft. from St. Louis to the gulf can be maintained for a period longer than the annual period of navigation on the great lakes; and that by additional work an 18-ft. depth for a longer period can be attained. No estimates are given of the cost of obtaining and maintaining such depths. The Chicago-St. Louis section is then dealt with, the cost of which is estimated at $30,100,000 for a 14-ft. depth, or $31,500,000 with locks of 20 ft. in depth. The questions of water power and land reclamation are also discussed in relation to the Illinois section.

THE NEW YORK, BROCKTON AND BOSTON CANAL.—Its Importance to Massachusetts Industries and Great Value to the Nation. (John J. Whipple, President, New York, Brockton and Boston Canal & Transportation Co., Brockton, Mass.) Stiff paper; 9 × 11½ ins.; pp. 78; folding plates and text illustrations.

The canal enterprise of which this pamphlet is a prospectus is not the familiar old Cape Cod Canal, which has been a subject for agitation for so many years, but is an overland route proposed to connect the waters of Boston Bay and Narragansett Bay, the route being from a point on the Fore River, near Weymouth, by way of Brockton to the head of navigation on the Taunton River, near the city of Taunton. The summit elevation of the proposed canal would be about 130 ft., and a preliminary estimate of cost, made by the Massachusetts Board of Harbor and Land Commissioners in 1902, was $57,600,000. Apparently no very detailed surveys and estimates of the route have ever been made. Geographically the old Cape Cod Canal would seem a much more favorable location for a water cut-off to save the detour around Cape Cod, but it is stated in this pamphlet that the objection to the Cape Cod Canal is the shifting sands and exposed waters at its terminals. The pamphlet contains a great deal of matter regarding the general subject of water transportation, with notable views of a number of foreign ship and bridge canals.

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Deep Foundations.

ALLOWABLE PRESSURES ON DEEP FOUNDATIONS.—By Elmer Lawrence Corthell, D. Sc., M. Inst. C. E. New York: John Wiley & Sons. Cloth; 5¼ × 8¾ ins.; pp. 98; eight folding plates and two text illustrations. $1.25, net.

In 1902, Dr. Corthell was chairman of a board, appointed by the Argentine National Government, engaged in reporting on the construction of a port at the city of Rozario, on the Parana River. One of the principal points of discussion brought before the engineers was the allowable pressure upon the material composing the bed of the river. The wide range of safe values proposed by the various members of the board led Dr. Corthell to start an investigation, through published reports and personal statements of engineers the world over, into the accepted values for safe bearing power on deep foundations in various kinds of soils.

The investigation, carried out by Mr. Charles R. Wychoff, Jr., under Dr. Corthell's direction, consisted of a study of the whole literature of the subject; also of responses to a circular letter sent to prominent engineers engaged in deep foundation work. The results of the study were first presented as a paper to the Institution of Civil Engineers, and the present book is an amplified form of this paper.

The admirable form of the compilation, and the thoroughness with which the abstracts of published articles have been made, make the book one of great value. Unfortunately, only about 30 replies containing useful data were received to some 300 circular letters, but, together with the abstracted accounts and personal statements, the investigation covers 178 examples of deep foundation work. Out of this number, 54 are described in more or less detail and all are included in a set of tables at the end. The tables list each example under 21 subheads, covering the full description of its history, loading and condition. A very complete bibliography accompanies the report.

As a result of the study, an analysis of the tables is made, showing the safe values allowable on different kinds of soil, dividing the material into fine sand, course sand and gravel, sand and clay, alluvium and silt, hard clay and hardpan. This list was given in Engineering News for Dec. 20, 1906.

THE OPERATION, CARE AND REPAIR OF AUTOMOBILES.—Edited from the Files of the Horseless Age, by Albert L. Clough. New York: The Horseless Age. Cloth; 5¾ × 9¼ ins.; pp. 343; 158 illustrations in the text. $1.

Assuming that a large proportion of the attention required in the care and maintenance of automobiles is demanded by the ignition apparatus, this book is introduced by considerable matter on the fundamental principles of electricity, arranged progressively; naturally, in this section considerable attention is given to coils and their attachments. Chapters on primary and secondary batteries augment this section of the work, as well as matter relative to generators for ignition and charging.

The book is adapted more to the use of those wishing to qualify as experts or repair men than to use by novices—persons wishing to drive their own cars, for example, and be able to cope with ordinary road troubles, but relying on the garages for the more detailed care of their cars.

The last one-third of the book is almost entirely devoted to garage and repair-shop practice, "wrinkles," etc.

THE CARE OF ELECTRIC MINE LOCOMOTIVES IN SERVICE.—By F. L. Sessions. Bulletin No. 12, March, 1907. Columbus, O.: The Jeffrey Mfg. Co. Paper; 8 × 10 ins.; pp. 80; illustrated.

This publication, a substantial one of 80 pages, is worthy of more than mere mention under "Trade Publications." It gives complete circuit diagrams, and part illustrations of the type of locomotives used in mines, as well as illustrations of various complete equipments. Chapters on the care of various parts of such a locomotive, and sundry cures for locomotive troubles, make it a book which coal operators could well afford to place in the hands of their motive-power men.

QUICK RULES FOR HEATING AND VENTILATING.—By William J. Baldwin, Jr., Heating and Ventilating Engineer. New York: The Author (1181 Broadway). Cloth; 4½ × 6¼ ins.; pp. 24. $1.

The author has compiled several brief rules which he states may be of occasional assistance to the architect in determining the kind of apparatus most suitable for particular cases, and the sizes and proportions of parts of systems. It would seem that an architect of any ability at all, should know everything contained in this book.

TECHNICAL DIGEST.—June 1, 1907. Pittsburg, Pa.: The Westinghouse Co.'s' Publishing Department. Paper; 4¼ × 8½ ins.; pp. 17.

This digest is prepared from the leading technical and trade magazines and from papers of the American and British engineering societies, especially for the use of salesmen and engineers of the various Westinghouse concerns.

Publications Received.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.—Report of the Committee on Municipal Ownership at the 1906 Convention. New York: The Association (B. V. Swenson, Secy., 29 West 39th St.). Paper; 6 × 9 ins.; pp. 25.

BOARD OF GAS AND ELECTRIC LIGHT COMMISSIONERS OF THE COMMONWEALTH OF MASSACHUSETTS.—Report for the Calendar Year 1906, Including Tables from the Annual Returns for the Year Ending June 30, 1906. Boston, Mass.: Pub. Doc. (No. 35). Paper; 5¾ × 9¼ ins.; pp. 218 + cc.

BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK.—Annual Report, 1906. (John S. Kennedy, Secy.). Three Volumes. Albany, N. Y.: Pub. Doc. Cloth; 5½ × 9 ins.; pp. lxxxiii. + 791 + 1,498 + 782; folding and other plates, and one folding map in pocket.

BROOKLYN ENGINEERS' CLUB.—Proceedings for 1906, Constitution and By-Laws, and Catalogue of Reference Works Added to the Library During the Year. Brooklyn, N. Y.: Brooklyn Engineers' Club (Joseph Strachan, Secy., 197 Montague St.). Paper; 6 × 9 ins.; pp. 229; plates and text illustrations. $2.

BULLETINS, BUREAU OF THE CENSUS.—S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9¼ × 11½ ins.

No. 77: Census of Manufacturers: 1905. Lumber and Timber Products. Pp. 69; ten plates.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 287: The Juneau Gold Belt, Alaska, by Arthur C. Spencer, and A Reconnaissance of Admiralty Island, Alaska, by Charles Will Wright. Pp. 161; 37 plates (two in pocket) and 41 text illustrations.

No. 312: The Interaction between Minerals and Water Solutions, with Special Reference to Geologic Phenomena. By Eugene C. Sullivan. Pp. 69.

COMMISSION OF GAS AND ELECTRICITY OF THE STATE OF NEW YORK.—Second Annual Report. (Henry C. Hazzard, Secy.). Albany, N. Y.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 671.

CONCRETE-STEEL BUILDINGS.—Being a Companion Volume to the Treatise on "Concrete-Steel." By W. Noble Twelvetrees, M. Inst. M. E., Assoc. M. Inst. E. E., Author of "Structural Iron and Steel." London and New York: Whittaker & Co. Cloth; 5 × 7½ ins.; pp. 408; 331 illustrations in the text. $3.25, net.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.—Papers and Transactions for 1906, and Proceedings of the 23d Annual Meeting, at Hartford, Feb. 12 and 13, 1907. (J. Frederick Jackson, Secy., New Haven, Conn.) Paper; 6 × 9¼ ins.; pp. 223; folding plates and text illustrations.

THE ELEMENTS OF MECHANICS.—A Text-Book for Colleges and Technical Schools. By W. S. Franklin and Barry MacNutt. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5½ × 8¾ ins.; pp. 283; 180 text illustrations and 1 plate. $1.50, net.

ERMITTELUNG DER BILLIGSTEN BETRIEBSKRAFT FUR FABRIKEN.—Unter Berücksichtigung der Heizungskosten sowie der Abdampfverwertung. By Karl Urbahn. Berlin, Germany: Julius Springer. Paper; 5¾ × 8¾ ins.; pp. 130; 23 illustrations in the text. 2.40 marks; American price, 96 cts.

EXPERIMENTS WITH METHODS FOR THE RAPID DETECTION OF GELATIN LIQUEFACTION IN THE DETERMINATION OF B. COLI.—Stephen DeM. Gage. (Reprinted from The Journal of Infectious Diseases, 1907, Supplement No. 3.) Paper; 6¾ × 9½ ins.; pp. 20 to 20.

FIRE TESTS WITH FLOORS.—A Floor of Reinforced Brick and Concrete on the Eggert Girderless System, Constructed by Messrs. C. Simeons & Co., Ltd., London. No. 118, "Red Books" of the British Fire Prevention Committee. London, England: The Committee (Edwin O. Sachs, Chairman of the Executive). Boards: 5½ × 8½ ins.; pp. 18; illustrated. 2½s.; American price, $1.

HOW TO DESIGN A GAS ENGINE.—With Full Working Drawings for a 7 B. HP. Gas Engine. By Horace Allen. Manchester, England: The Scientific Publishing Co. Cloth; 7¼ × 10 ins.; pp. 39; 20 illustrations in the text. 2s. 6d., net; American price, $1, net.

PRACTICAL ADVICE FOR MARINE ENGINEERS.—By Charles W. Roberts, Author of "Drawing and Designing for Marine Engineers," etc. Second Edition, thoroughly revised and rewritten. London, England: Whittaker & Co. Cloth; 5 × 7½ ins.; pp. 206; 82 illustrations, mostly in the text. $1.

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